ISSN 0377-9335

entomon

A Quarterly Journal of Entomological Research

Vol. 8 MARCH 1983 No. 1

PUBLISHED BY
THE ASSOCIATION FOR ADVANCEMENT OF ENTOMOLOGY
DEPARTMENT OF ZOOLOGY, UNIVERSITY OF KERALA, KARIAVATTOM
TRIVANDRUM, INDIA 695 581

ENTOMON

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Annual subscription for institutions:	Rs 150/- (in India);	\$ 50/- (abroad)
,, ,, individuals:	Rs 50/- ,, ;	\$ 20/- ,,

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entomon

Volume 8 **March 1983** **Number 1**

CONTENTS

Phytophagous mite fauna of Assam together with new records and new species—**G. L. Sadana** and **B. K. Gupta** 1

A new species of *Chaitophorus* (Homoptera : Aphididae) from Orissa—**M. Basu** and **D. Raychaudhuri** 7

New and hitherto not known species of aphids (Homoptera : Aphididae) producing leaf galls in the north west himalayas, India—**D. K. Bhattacharaya, A. K. Mandal** and **S. Chakrabarti** 13

The effect of temperature and humidity on different nymphal instars of *Pyrilla perpusilla* Walker—**Mridula Gupta** and **Islam Ahmed** 19

Study on aphid tending ants in India.II. New records of aphid and ant species in their association—**S. K. Datta, D. Raychaudhuri** and **Basant K. Agarwala** 23

Parasitoids and predators of aphids (Homoptera : Aphididae) From India. VI. New records of seven arachnids, one dipteran and one neuropteran predators from Himachal Pradesh, India—**S. K. Das** and **D. Raychadhuri** 27

Parasites and predators of rose infesting aphids (Homoptera : Aphididae) in India—**Basant K. Agarwala** 35

Influence of foliar application of insecticides on the resurgence of brown planthopper, *Nilaparvata lugens* (Stal) on rice—**K. Raman** and **S. Uthamasamy** 41

Analysis of wing vibration of mosquito *Anopheles stephensi*—**Syed Najmul Hasan, Adeel Ahmad** and **N. Chari** 47

Effect of thermostable exotoxin of *Bacillus thuringiensis* Berliner on *Achaea janata* L.—**A. D. Deshpande** and **N. Ramakrishnan** 35

Sequential sampling plan for cabbage leafwebber, *Crocidolomia binotalis* (Zell)—**C. L. Suman** and **S. D. Wahi** 61

Field evaluation of certain synthetic pyrethroids for the control of *Cydia leucostoma* Meyr. (Olethreutidae : Lepidoptera), the flushworm of tea—**N. Muraleedharan** and **C. Kandasamy** 67

Biochemical studies on DNA, RNA and protein contents of the labial glands during postembryonic development in *Spodoptera litura* (Noctuidae: Lepidoptera)—**C. G. Prasada Rao, Aparna Ray** and **P. S. Ramamurty** 71

Studies on host preference of *Aphis craccivora* Koch.—**K. Dharma Reddy, V. P. Gargav** and **D. S. Misra** 75

Ashweevil (*Myllocerus subfasciatus* Guerin) damage on eggplant (*Solanum melongena* L.) and economics of its control—**G. C. Tewari** and **N. K. Krishna Kumar** 79

Relationship between size of *Eucelatoria bryani* Sabrosky females and their longevity and fecundity—**M. Mani** and **S. Nagarkatti** 83

Susceptibility of two braconid parasites *Apanteles angaleti* Muesebeck and *Bracon kirkpatricki* (Wilkinson) to several chemical pesticides—**M. Mani** and **Sudha Nagarkatti** 87

BRIEF COMMUNICATIONS

New aphid parasitoids (Hymenoptera: Aphidiidae) from West Bengal, India—**A. K. Samanta, D. K. Tamili, J. L. Saha** and **D. Raychaudhuri** 93

Parasitism, a key factor in checking rice pest populations—**C. Subba Rao, N. Venugopal Rao** and **S. A. Razvi** 97

Field evaluation of various doses of phorate and aldicarb for the control of two-spotted spider mite, *Tetranychus urticae* Doce on Thompson seedless grapevines—**A. R. Mali, D. N. Gandhale** and **A. S. Patil** 101

Occurrence of *Charops hersei* G. & M. as a parasite on taro hornworm *Hippotion oldenlandiae* F.—**M. S. Palaniswami** and **K. S. Pillai** 103

Nomenclatural studies of genus *Aulacophora* Duponchel & Chevrolat and *Aulacophora foveicolls* (Lucas)—**J. S. Mann** and **A. S. Sohi** 105

BOOK REVIEW 107

ANNOUNCEMENTS 108

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Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 1 *to* 6

PHYTOPHAGOUS MITE FAUNA OF ASSAM TOGETHER WITH NEW RECORDS AND NEW SPECIES

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(Received 21 February 1982)

Seven species of Tetranychoid mites are reported from the Assam State. Of these, three species viz. *Brevipalpus assamensis, B. gauhatiensis, B. tinsukiaensis* are new. The genus *Ultratenuipalpus* and the species *Ultratenuipalpus meekeri* (Deleon), 1957, *Tetranychus puschelii* Meyer, 1974 are reported for the first time from India.

(*Key words:* mite fauna of Assam, new records, new species)

The phytophagous mite fauna of Assam State is rather poorly known. So far, only twelve Tetranychoid mites are known to infest various economic plants of the State (Ghai, 1964; Gupta, 1976; Prasad, 1974). During an extensive survey, seven species of Tetranychoid mites infesting different economic plants were encountered. These species belong to the genera *Brevipalpus*, *Ultratenuipalpus*, *Tetranychus* and *Eutetranychus*. The genus *Ultratenuipalpus* and the species *Ultratenuipalpus meekeri* (Deleon) and *Tetranychus puschelii* Meyer are recorded for the first time from India. Three new species of the genus *Brevipalpus* Donnadieu were also encountered which are described here. In addition, many new host plants of these mites have been recorded which are marked with asterisks in their collection data. With the additions of the present records to the already known mite fauna, the total number of Tetranychoid mites now known from the Assam State stands at seventeen.

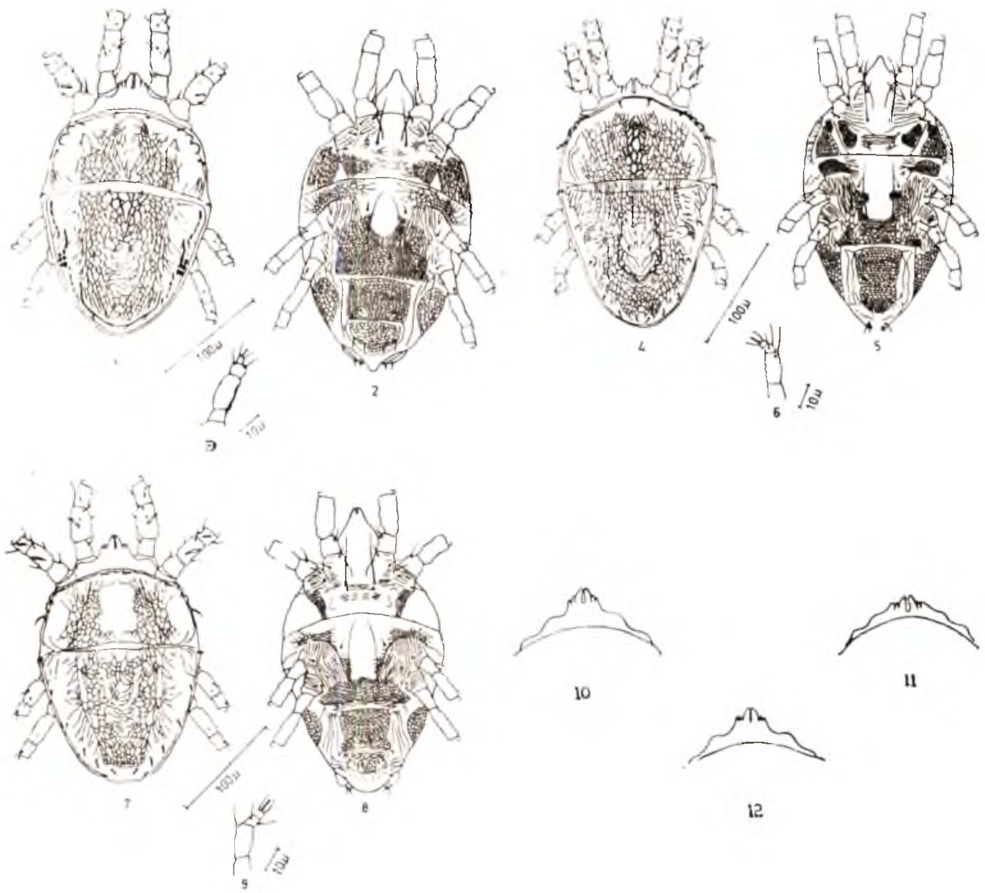
1. **Brevipalpus assamensis** sp. nov.

(Fig. 1—3, 10)

Female: Body 300.50[1] long including rostrum and 175 wide. Palpus 4 segmented, with 1 sensory rod and 2 setae on terminal segment. Rostral shield deeply notched with a median and 4 lateral lobes on each side. Rostrum reaching upto middle of femur I. Propodosoma with reticulations mediolaterally; irregular and broken striations medially; bare laterally. Propodosomal setae 3 pairs, lanceolate and serrate, measuring, 5, 5 and 7.50 respectively. Eyes 2 pairs, 1 pair on each side. Humeral setae 1 pair, each seta 5 long. Hysterosoma with reticulations meeting caudally; faint reticulations anteromedially; transverse and broken striations in the rest of median portion; irregular and broken striations laterally. Dorsocentral setae 3 pairs, measuring 6.25 5 and 5 respectively. Dorsolateral setae 5 pairs, lanceolate, serrate and located close to a thick band, I 5, II 5, III 7.50, IV 7.50, V 7.50 long.

Ventrally, propodosoma with a few striations and reticulations near the bases of coxae I and II. Reticulations inner and lateral to the posterior apodemes of coxae II. Area anterior to coxae III, in front of coxae IV, anterior and lateral to ventral shield, inner to the bases

[1]Measurements are in μm, unless otherwise stated.



Figs. 1—3 *Brevipalpus assamensis* sp. nov. 1. Dorsal view (Legs partially shown); 2. Ventral view (Legs partially shown); 3. Palpus. Figs. 4—6 *Brevipalpus gauhatiensis* sp. nov. 4. Dorsal view (Legs partially shown); 5. Ventral view (Legs paratially shown); 6. Palpus. Figs. 7—9 *Brevipalpus tinsukiaensis* sp. nov. 7. Dorsal view (Legs partially shown); 8. Ventral view (Legs partially shown); 9. Palpus. Figs. 10—12 Rostral shilds of *Brevipalpus assamensis* sp. nov., *B. gauhatiensis* sp. nov. and *B. tinsukiaensis* sp. nov. respectively.

of posterior medioventral metapodosomal setae with reticulations whereas area in front of coxae III and on coxae IV with striations. Ventral and genital shields reticulated. Ventral propodosomal setae 1 pair, long, each measuring 40; anterior medioventral metapodosomal setae 1 pair, each measuring 6.25; posterior medioventral metapodosomal setae 1 pair, long, each measuring 37.50; ventral shield setae 1 pair, each measuring 5; genital shield setae 2 pairs, setae of both pairs being 12.50 long; anal setae 2 pairs. All setae on venter simple.

Legs 4 pairs, segments wrinkled. Setae and solenidia (in parentheses) on legs I-IV; coxae 2-2-1-1; trochanters 1-1-2-1;

femora 4-4-2-1; genua 3-3-1-1; tibiae 5-5-3-3; tarsi 7(1)-7(1)-5-5.

Male: Not known.

Holotype: ♀, encircled on slide No. A73b, ex. unidentified plant, 14.v.1981, New Bongaigaon, Coll. Sita Ram.

Paratypes: 2 ♀♀ and 1 ♀ on slide Nos Ala and b, ex. *Tagetes erecta*, 7.v.1981, Kismadarika (Kamrup, Assam); 6 ♀♀ on slide No. A15, ex. *Pergularia daemia*, 6 ♀♀ on slide No. A40a, ex. *Ocimum sanctum*, 9.v.1981, Tinsukia; 6 ♀♀ on slide No. A23, ex. *Jasminum grandiflora*, 4 ♀♀ and 5 ♀♀ on slide Nos. A 32a and b, ex, *Plumeria acutifolia*, 10.v.1981, Dibrugarh; 10 ♀♀, 8 ♀♀, 8 ♀♀ and 10 ♀♀ on slide Nos. A 60a, b, c and d; ex. *Helianthus annus*, 15 ♀♀, 14 ♀♀ and 15 ♀♀ on slide Nos. A62a, b, and c, ex. *Dahlia* sp., 8 ♀♀ and 14 ♀♀ on slide Nos. A63a and b, ex. Glare, 8 ♀♀ on slide No. A70a, ex. *Ocimum sanctum*, 12.v.1981, Gauhati; 15 ♀♀, 15 ♀♀, 10 ♀♀ and 8 ♀♀ on slide Nos. A72a, b, c and d, ex. *Ipomoea reptans*, 7 ♀♀ and 14 ♀♀ on slide Nos. A73a and b, ex. unidentified plant, 14.v.1981, New Bongaigaon, Coll. Sita Ram.

Remarks: *Brevipalpus assamensis* sp. nov. resembles *B. obovatus* Donnadieu (Chaudhri, Akbar and Rasool, 1974) but differs from it in structure of rostral shield i e., in having 4 lateral lobes on each side instead of 3 as in *B. obovatus*, pattern of reticulations on dorsum and venter and in having 2 setae on trochanter III instead of 1 seta as in *B. obovatus*. It also resembles *B. amicus* Chaudhri, 1972 but differs in rostral shield structure; pattern of reticulations on dorsum and venter.

2. Brevipalpus gauhatiensis sp. nov. (Figs. 4-6, 11)

Female: Body 300 long including rostrum and 155 wide. Palpus 4 segmented, with 1 sensory rod and 2 setae on terminal segment. Rostral shield deeply notched, with a median and 4 lateral lobes on each side. Rostrum reaching upto middle of femur I. Propodosoma with reticulations mediolaterally, median area with complete or incomplete areolae, bare laterally. Propodosomal setae 3 pairs, lanceolate and serrate, measuring 12.50, 12.50 and 13.75 respectively. Eyes 2 pairs, 1 pair on each side. Humeral setae 1 pair, each seta 3.75 long. Hysterosoma with reticulations meeting caudally, complete or broken reticulations medially, irregular striations laterally. Dorsocentral setae 3 pairs, all being 5 long. Dorsolateral setae 5 pairs, lanceolate and serrate, I 7.50, II 7.50 III 10, IV 10, V 10 long.

Ventrally, propodosoma with a few striations near the bases of coxae I and II. Reticulations inner and lateral to the posterior apodemes of coxae II. Area anterior to coxae III, anterior and lateral to ventral shield with reticulations whereas area in front of coxae III and IV with striations. Area inner to the bases of anterior and posterior medioventral metapodosomal setae bare. Ventral and genital shields reticulated. Ventral propodosomal setae 1 pair, long, each measuring 52.50; anterior medioventral metapodosomal setae 1 pair, each measuring 6.25; posterior medioventral metapodosomal setae 1 pair, long, each measuring 57.50; ventral shield setae 1 pair, each measuring 6.25; genital shield setae 2 pairs, both pairs being 12.50 long; anal setae 2 pairs. All setae on venter simple.

Legs 4 pairs, segments wrinkled. Setae and solenidia (in parentheses) on legs I-IV: coxae 2-2-1-1; trochanters 1-1-2-1; femora 4-4-2-1; genua 3-3-1-1; tibiae 5-5-3-3; tarsi 5 (1)-5 (1)-4-4.

Holotype: ♀, encircled on slide No. A65, ex. *Jasminum grandiflora*, 12.v.1981, Gauhati, Coll. Bimal Kumar Gupta.

Paratypes: 7 ♀♀ on slide No. A65, ex. *Jasminum grandiflora*; 1 ♀ on slide No.A60, ex. *Helianthus annus*, 12.v.1981, Gauhati, Coll. Bimal Kumar Gupta.

Remarks: *Brevipalpus gauhatiensis* sp. nov. resembles *B. obovatus* Donnadieu (Chaudhri, Akbar and Rasool, 1974) but differs from it in structure of rostral shield; presence of areolae medially on propodosoma; reticulations pattern of dorsum and venter. Trochanter III has 2 setae instead of 1 seta as in *B. obovatus*. It also resembles *B. assamensis* sp. nov. but differs from it in presence of areolae medially on propodosoma and reticulation pattern of dorsum and venter.

3. Brevipalpus tinsukiaensis sp. nov. (Figs 7-9, 12)

Female: Body 300 long including rostrum and 150 wide. Palpus 4 segmented, with 1 sensory rod and 2 setae on terminal segment. Rostral shield deeply notched with a median and 4 lateral lobes on each side. Rostrum extending beyond the middle of femur I. Propodosoma with reticulations medio-laterally, bare medially and laterally. Propodosomal setae 3 pairs, lanceolate and serrate, measuring, 7.50, 7.50 and 10 respectively. Eyes 2 pairs, 1 pair on each side. Humeral setae 1 pair, each sete 3.75 long Hysterosoma with reticulations meeting, caudally, incomplete reticulations medially, oblique striations laterally. Dorsocentral setae 3 pairs, measuring, 7.50, 6.25 and 6.25 respectively. Dorsolateral setae 5 pairs, lanceolate and serrate, I 5, II 6.25, III 6.25, IV 6.25, V. 6.25 long.

Ventrally, propodosoma with a few striations and reticulations near the bases of coxae I and II. Area inner to posterior apodemes of coxae II, anterior to coxae III, posterior to coxae IV, anterior and lateral to ventral shield with reticulations whereas area in front of coxae III and IV with irregular striations. Area inner to bases of anterior and posterior medioventral metapodosomal setae bare. Ventral and genital shields reticulated. Ventral propodosomal setae 1 pair, long, each measuring 50; anterior medioventral metapodosmal setae 1 pair, each measuring 7.50; posterior medioventral metapodosomal setae 1 pair, long, each measuring 55; ventral shield setae 1 pair, each measuring 7.50; genital shield setae 2 pairs, members of both pairs measuring 12.50; anal setae 2 pairs. All setae on venter simple.

Legs 4 pairs, segments wrinkled. Setae and solenidia (in paranthesis) on legs I-IV: coxae 2-2-1-1; trochanters 1-1-1-0; femora 4-4-2-1; genua 3-3-1-1; tibiae 5-5-3-3; tarsi 7 (2)-7(2)-5-5.

Male: Podosoma broad anteriorly, opisthosoma narrowed posteriorly. Dorsum differentiated into propodosoma, metapodosoma and opisthosoma by two transverse sutures.

Holotype: ♀, encircled on slide No.A40a, ex. *Ocimum sanctum*, 9.v.1981, Tinsukia, Coll. Sita Ram.

Paratypes: 1♀ on slide No.A3, ex. *Zizyphus jujuba*, 7.v.1981, Kismadarika (Kamrup, Assam); 10 ♀♀; 11 ♀♀ and 10 ♀♀, 1 ♂ on slide Nos. A4a, b and c. ex. *Citrus limon*, 3 ♀♀ on slide No. A40a, ex. *Ocimum sanctum*, Tinsukia; 1 ♀ on slide No. A22. ex. *Citrus limon*, 2 ♀♀ on slide No. A23, ex. *Jasminum grandiflorv*, 5 ♀♀ and 2 ♀♀ on slide Nos. A 32a and b, ex. *Plumeria acutifolia*, 10.v.1981, Dibrugarh, Coll. Sita Ram.

Remarks: *Brevipalpus tinsukiaensis* sp. nov. resembles *B. rugulosus* Chaudhri,

Akbar and Rasool, 1974 but differs from it in having different reticulation pattern on dorsum. In the present from the medial propodosomal portion is bare but in *B. rugulosus* it bears irregular broken striations. It further differs in having reticulated anteromedian area in front of ventral shield. The genital setae are not serrated. Trochanter III and IV have 1 and 0 setae respectively instead of 2 and 1 as in *B. rugulosus*.

4. **Ultratenuipalpus meekeri** (Deleon), 1957

Tenuipalpus meekeri Deleon, 1957, *Fla. Ent.* **40** (3): 82—93.

Collection data: 1 ♀ each on slide No. A 73 a and b, ex. unidentified plant, 14.v.1981, New Bongaigaon (Assam), Coll. Sita Ram Yadav.

Remarks: Deleon (1957) reported this species from Mexico. The authors are reporting this species and the genus for the first time from India.

5. **Tetranychus puschelii** Meyer, 1974

Tetranychus puschelii Meyer, 1974, *Entomology Mem. Dep. agric. tech. Serv. Repub. S. Afr.* **36**: 292 pp.

Collection data: 10 ♀♀ on slide No. A2, ex *Cucumis sativa**, 7.v.1981, Patiladaha (Kamrup, Assam); 12. ♀♀ 1 ♂; 11 ♀♀. and 12 ♀♀ on slide Nos. A5a, b and c, ex. *Ocimum basilicum**, 10 ♀♀, 12 ♀♀ and 6 ♀♀ on slide Nos. A7a, b and c, ex *Chrysanthemum** sp , 5 ♀♀, 8 ♀♀ and 9 ♀♀ on slide Nos. 10a, b and c, ex *Jasminus sambac**, 6 ♀♀; 9 ♀♀ and 10 ♀♀, 1 ♂ on slide Nos. A 11 a, b, and c, ex *Tagetes erecta**, 12 ♀♀, 10 ♀♀ and 14 ♀♀ on slide Nos. A12a, b and c, *Calendula officinalis**, 15 ♀♀, 1♂ and 15 ♀♀ on slide Nos. A16a and b, ex. *Ranunculus** sp., 16 ♀♀ and 21 ♀♀ on slide Nos. A17a and b, ex. *Cannabis sativa**, 8.v.1981, Tinsukia; 15 ♀♀, 10 ♀♀ and 12 ♀♀ on slide Nos. A13a, b and c, ex. *Abutilon ramosum*,* 7.v.1981, Kismadarika (Kamrup, Assam); 15 ♀♀, 12 ♀♀ and 15 ♀♀ on slide Nos. A19a, b and c, ex. *Helianthus annus**, 12 ♀♀, 8 ♀♀ on slide Nos. A20a, and b, ex. *Dahlia**, sp., 9.v.1981, Tinsukia; 2 ♀♀ on slide No. A21, ex. unidentified plant, 9 ♀♀, 1 ♂ on slide No. A24, ex. *Carica papaya**, 2 ♀♀ on slide No. A25, ex. *Capsicum annum**, 8 ♀♀ 1 ♂ on slide No. A27, ex. *Cannabis sativa**, 6 ♀♀ and 5 ♀♀ on slide Nos. A 29a, and b, ex. *Cosmos* sp., 5 ♀♀ and 5 ♀♀ on slide Nos. A 30a, and b, ex. *Helianthus annus**, 9 ♀♀, 1 ♂; 5 ♀♀ and 6 ♀♀ on slide Nos. A31a, b and c, ex. *Tagetes erecta**, 14 ♀♀, 1 ♂; 12 ♀♀ and 8 ♀♀ on slide Nos. A35a, b and c, ex. *Cucumis sativus**, 9 ♀♀ and 12 ♀♀ on slide Nos. A36a, and b, ex. *Lagenaria leucontha**, 15 ♀♀, 4 ♀♀ on slide Nos. A37a, and b, ex. *Xanthium strumarium**, 8 ♀♀; 11 ♀♀, 1 ♂ and 11 ♀♀ on slide Nos. A39a, b and c, ex. *Solanum melongena**, 10.v.1981, Dibrugarh; 15 ♀♀ and 15 ♀♀ on slide Nos. A41a and b, ex. *Cucumis melo* var. *utilissima**, 12 ♀♀, 10 ♀♀ and 11 ♀♀ on slide Nos. A42a, b and c, ex. *Glycine max**, 12 ♀♀ and 20 ♀♀ on slide Nos. A44a and b, ex *Hibiscus esculentus**, 14 ♀♀ on slide No. A51, ex. *Solanum melongena**, 13 ♀♀ on slide No. A52, ex. *Helianthus annus**, 9.v.1981, Tinsukia, Coll. Sita Ram. 7 ♀♀ and 8 ♀♀ on slide Nos. A59a and b, ex. *Chenopodium ambrosioides** 11.v.1981, Gauhati, Coll. Bimal Kumar Gupta.

Remarks: The present form closely resembles *Tetranychus puschelii* Meyer but differs from it in having unlobed ventral striae. This difference is considered as intra-specific variation and the present form is referred as *T. puschelii*. This species has been recorded for the first time in India on many new host plants marked with asterisks in collection data.

6. Brevipalpus phoenicis (Geijskes) 1939

Collection data: 1♀ each on slide Nos. A62a and c, ex. *Dahlia** sp; 1 ♀ on slide No. A70a, ex. *Ocimum sanctum**, 12.v.1981, Gauhati, Coll. Sita Ram Yadav.

7. Eutetranychus orientalis (Klein), 1936

Collection data: 10 ♀♀, 1♂; 15 ♀♀ and 12 ♀♀ on slide Nos. A 53a, c and d, ex. *Zizyphus jujuba*; 10 ♀♀, 1 ♂; 12 ♀♀, 1♂ and 3 ♀♀ on slide Nos, 56a, b and c; ex. *Ricinus communis*, 3 ♀♀; 10 ♀♀, 1 ♂ and 12♀♀ on slide Nos. A 57a, b and c; ex. *Tabernaemontana divaricata*, 11. v. 1981, Gauhati, Coll. Bimal Kumar Gupta.

Acknowledgements: The authors are thankful to Dr. S. S. Guraya, Professor and Head, Department of Zoology, Punjab Agricultural University, Lndhiana for laboratory facilities and I C A R, for financing the scheme to carry out the taxonomic work on tetranychoid mites. The help rendered by Sita Ram is gratefully acknowledged.

REFERENCES

Chaudhri, W. M. (1972) The genus *Brevipalpus* in Pakistan. I. Description of six new species and redescription of one species with new records. *Pak. J. Zool.*, **4** (1), 53—88.

Chaudhri, W. M., S. Akbar & A. Rasool (1974) Taxonomic studies of the mites belonging to lhe families Tenuipalpidae, Tetranychidae, Tuckerellidae, Caligonellidae, Stigmaeidae and Phytoselidae *PL-480 Project on Mites, University of Agriculture, Lyallpur, Pakistan*, pp 1—250.

Deleon, D. (1957) The genus *Tenuipalpus* in Mexico (Acarina : Tenuipalpidae). *Fla. Ent.*, **40** (3), 82—93.

Ghai, S. (1964) Mites, *in: Entomology in India*. Silver Jublee Number, E S I., 385—296.

Gupta, S. K. (1976) Contribution to our knowledge of Tetranychid mites (Acarina) with descriptions of three new species from India. *Oriental Ins.*, **10** (3), 327—351.

Meyer, M. K. P. (1974) A revision of the Tetranychidae of Africa (Acari) with a key to the genera of the world. *Entomology Mem. Dep. agric. tech. Serv. Repub. S. Afr.*, **36**, pp. 292.

Meyer, M. K. P. (1979) The Tenuipalpidae (Acari) of Africa with keys to the world fauna. *Entomology Mem. Dep. agric. tech. Serv. Repub. S. Afr.*, **50**, pp. 135.

Prasad, V. (1974) *A Catalogue of Mites of India*. Indira Acarology Publishing House, Ludhiana (Punjab), India, pp 320.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 7 *to* 11

A NEW SPECIES OF CHAITOPHORUS (HOMOPTERA : APHIDIDAE) FROM ORISSA

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(*Received 15 January 1982*)

A new species of aphid, *Chaitophorus eugeniae* infesting *Eugenia heyneana* collected from Orissa, is described.

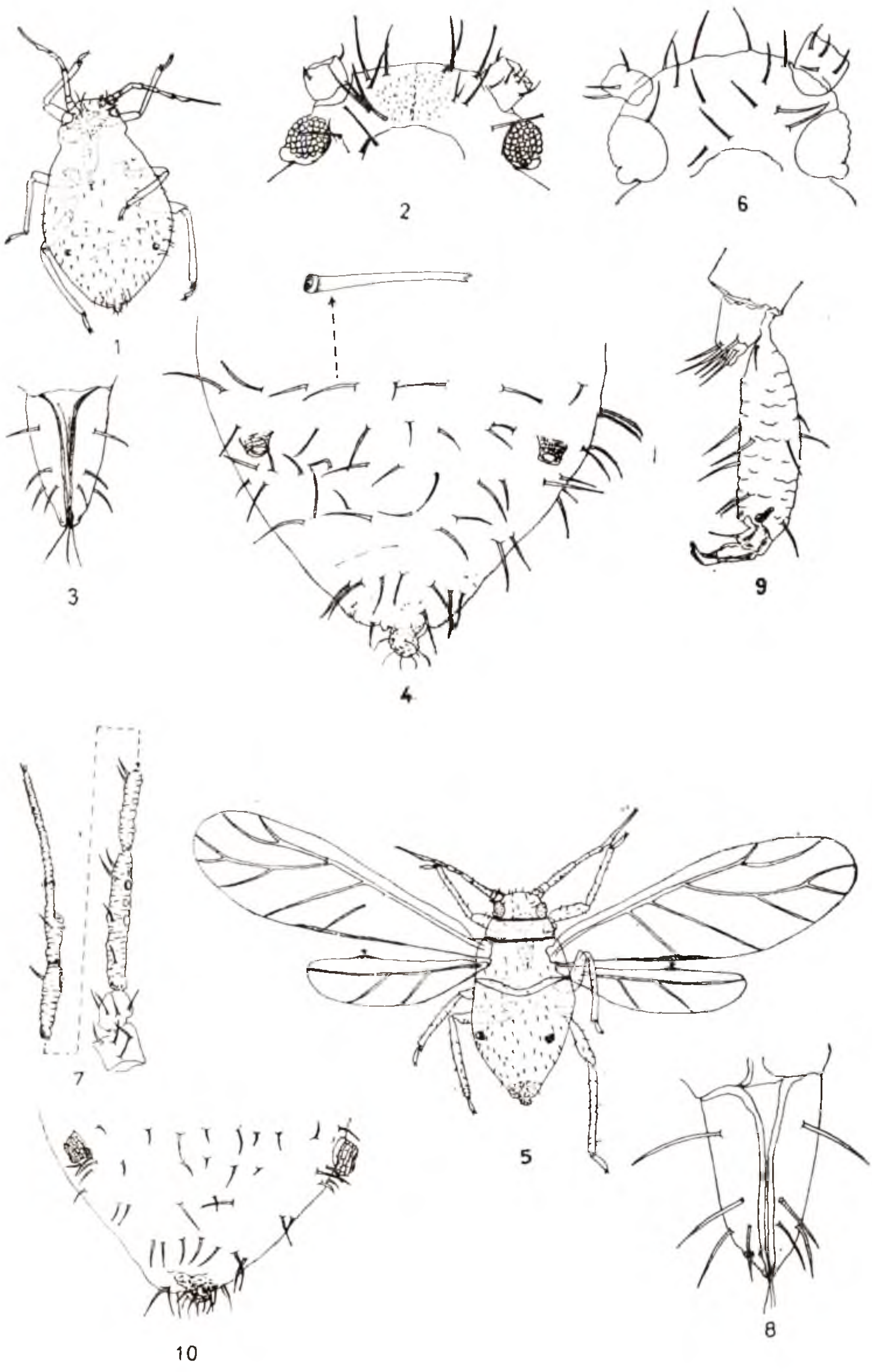
(*Key words:* new species, aphid, India)

Examination of aphid samples collected in Orissa during January, 1980 revealed a new species, which is described here.

Materials of the species are deposited in the collection of Entomology Laboratory, Department of Zoology, Calcutta University.

Chaitophorus eugeniae, sp. nov.

Apterous viviparous female: (Fig. 1): Body about 1.347-1.638 mm long with 0.694-0.847 mm as maximum width. Head (Fig. 2) pale; lateral frontal tubercles ill-developed; dorsum with indistinct nodules, dorsal cephalic hairs long and short, with pointed and furcated apices, longer hairs on high sockets and papillate base, about 34-108 μm long; the longest hair being about 3.1-4.3 and the shortest hair 1.3-2.5 times the basal diameter of antennal segment III. Eyes with distinct ocular tubercles. Antennae pale, about 0.43-0.47 times the body, segments I and II smooth, with 4-5 and 3-4 hairs respectively; flagellum gradually more distinctly imbricated apicad; processus terminalis as long as to slightly longer than segment III and about 2.1-2.8 times the base of segment VI; hairs on the flagellum sparse, with pointed apices; segment III with 3-7, IV with 2-4, V with 1-2 and the base of segment VI with 2 hairs; longest hair on segment III about 1-3-1.5 times the basal diameter of the segment. Rostrum reaching mid-coxae; ultimate rostral segment (Fig. 3) about 0.81-0.90 times the second joint of hind tarsus and with 2-4 accessory hairs. Thoracic dorsum without nodules, with about 11-12 hairs in prothorax, 27-28 hairs in mesothorax and 26-27 hairs in metathorax. Abdomen (Fig. 4) pale; dorsum smooth, dorsal hairs with acute and furcated apices and are of two types, the first type is shorter and thinner, the other type is longer and stouter; anterior tergites with about 12-13 hairs per segment 6th with 8-10 hairs between the siphunculi 7th with 9 hairs of which 3 hairs being relatively shorter, 8th with 7 hairs; longest hair on anterior tergites about 93-111 μm and shorter hairs about 18-43 μm long and about 3.7-4.0 times and 0.7-1.5 times respectively the basal diameter of antennal segment III; longest hairs on 7th and 8th tergites about 4.4-5.4 times the mentioned diameter. Venter of abdomen smooth anteriorly and with spinular nodules arranged in rows on posterior segments. Siphunculi pale, reticulated with transversely elongate cell, about 0.194-0.277 mm long and 1.1-1.5 times as long as the second



Chaitophorus eugeniae sp. nov. Figs. 1. Apterous viviparous female; 2. Head of aptera; 3. Ultimate rostral segment of aptera; 4. Posterior part of abdomen of aptera; 5. Alate viviparous female; 6. Head of alata; 7. Antenna of alata; 8. Ultimate rostral segment of alata; 9. Tarsi of alata; 10. Posterior part of abdomen of alata.

joint of hind tarsus. Cauda distinctly knobbed, about 0.041-0.097 mm long, knobbed portion with spinular imbrications, with about 5-7 hairs. Legs pale, smooth; hairs on legs with pointed apices tibiae with longer hairs on outer surface, apical tibial hairs undifferentiated from other tibial hairs; longest hair on tibiae about 43.4-77.5 μm long and about 1.5-2.7 times the basal diameter of antennal segment III; first tarsal segments with 5 hairs each; empodial hairs thin and setaceous.

Measurements of the holotype in mm: Length of body 1.52, width 0.84; antenna 0.72, antennal segments III:IV:V:VI: 0.16: 0.09:0.08: (0.07+0.19); ultimate rostral segment 0.09; second joint of hind tarsus 0.10; siphunculus 0.05; cauda 0.07.

Alate viviparous female (Fig. 5): Body about 1.38-1.50 mm long with 0.62-0.66 mm as maximum width. Head (Fig. 6) dark brown; dorsum smooth except a few striations near the bases of the hairs; dorsum of head with 12-14 long and stout hairs, mostly with pointed apices; longest hair about 62-65 μm long and about 2.8-3.0 times the basal diameter of antennal segment III. Antennae (Fig. 7) about 0.58-0.61 times the body; segments I and II slightly pale than the head, gradually and distinctly imbricated apicad; processus terminalis about 2.62-2.66 times the base of segment VI; segment III with about 5-7, IV with 2-5, V with 2 and base of segment VI with 2 hairs; hairs on the flagellum short to long, with pointed apices; longest hair on segment III about 1.3-1.7 times the basal diameter of the segment; segment III with 3-5 non-ciliated round to oval secondary rhinaria distributed towards the apical 0.5 portion of the segment, segments IV and V without secondary rhinaria. Ultimate rostral segment (Fig. 8) about 0.83-0.85 times the second joint of hind tarsus (Fig. 9) and with 2 accessory hairs. First and second thoracic segments pale brown, third dark brown. Abdomen (Fig. 10) pale throughout, dorsum smooth throughout except a few striations; dorsal hairs short to long, mostly with pointed apices, some of the longer hairs on distinct tuberculate bases; anterior tergites with about 14 hairs per segment; 6th tergite with about 12 hairs between the siphunculi; 7th tergite with 8 and 8th tergite with 7 hairs respectively; longest hair on anterior tergites about 3.1-3.2 times the basal diameter of antennal segment III; on 7th tergite about 3.8-4.0 times and on 8th tergite about 4.0-4.8 times respectively the mentioned diameter. Venter of abdomen smooth; ventral hairs thinner and shorter than the dorsal hairs Siphunculi pale, about 0.04-0.06 mm long, with transversely elongate cells, about 0.41-0.57 times the length of second joint of hind tarsus. Cauda pale, knobbed, with 6-8 long hairs. Subgenital plate with 18-19 hairs. Legs brown, nearly smooth; hairs on legs with pointed apices, tibiae with longer hairs towards the outer surface, apical tibial hairs undifferentiated from other tibial hairs; longest hair on tibiae about 46.5-58.9 μm long and about 2.1-2.7 times the basal diameter of antennal segment III; first tarsal segments with 5 hairs each. Wing venation normal, veins brown; hind wing with both oblique veins.

Measurements of one alata in mm: Length of body 1.50, width 0-66; antenna 0.87, antennal segments III: IV: V: VI 0.22: 0.12: 0.11:(0.08+0.21); second segment of hind tarsus 0.10; siphunculus 0.06; cauda 0.08.

Apteriod nymph: Body pale, about 1.01 mm long and about 0.40 mm as

maximum width. Antennae 5 segmented, about 0.48 times the body. Ultimate rostral segment reaches hind coxae and with one pair of accessory hairs. Hairs on dorsum of head and abdomen with pointed to furcated apices; anterior tergites ofabdomen with 9-11 hairs and 8th tergite with 7 hairs. Siphunculi indistinctly reticulated, about 0 04 mm long; cauda semicircular with 6 hairs. Legs pale, first tarsal chaetotaxy 5, 5, 5.

Alatoid nymph: Body pale, about 1.36 mm long and about 0.64 mm as maximum width. Antennae 5 segmented, about 0.37 times the body; antennal segment III without secondary rhinaria; ultimate rostral segment reaching hind coxae and with a pair of accessory hairs. Hairs on dorsum of head and abdomen with pointed to furcated apices; anterior tergites of abdomen with 9 hairs and 8th tergite with 8 hairs. Wing pads present on meso- and metathorax. Siphunculi pale, indistinctly reticulated; cauda semicircular and with 7 hairs. Legs pale, first tarsal chaetotaxy 5, 5, 5.

Holotype: Apterous viviparous female, India: Orissa: Keonjhar (Gopalpur), c 4ɔ3m 25.i.1980, from *Eugenia heyneana* (Myrtaceae), coll. M Basu. **paratypes**: Many apterous viviparous, alate viviparous females and nymphs of both apteroid and alatoid forms. Collection data as for the holotype.

Biological notes: Dense colony of light green apterae, alatae and nymphs infested both sides of leaves along the veins. The aphids are attended by red and black ants. Some of the aphids, on mounting, appeared to be infected by fungi.

Affinity: The new species in having body pale and smooth, body hairs pointed to furcated and first tarsal chaetotaxy 5,5,5 can be related to *Chaitophorus pakistanicus* H. R. L., *C. populeti* (Panzer) and *C. horii* Takahashi but can be distinguished from each of them as under.

a. from *C. pakistanicus* H. R. L., the new species stands distinct in having marginal dorsal hairs acute to furcated apices, tibiae without pseudosensoria like structures, u. r. s. bearing 2-4 accessory hairs and processus terminalis about 2.10-2.80 times the base of segment VI.

b. from *C. populeti* (Panzer) it differs in having u. r. s. blunt, bearing 2-4 accessory hairs and 0.81 to 0.90 times the second joint of hind tarsus, antennae 0.43-0.47 times the body in apterae, hind legs in alatae without pseudosensoria like structures. Abdominal dorsum pale and smooth.

c. from *C. horii* Takahashi the new species differs in having only 8 hairs on 6th abdominal segment between the siphunculi, the longest of these being about 3.45 time as long as the middle breadth of third antennal segment in apterae and the chaetotaxy of 3rd to 6th antennal segments 5-7, 2-5, 2, 2 respectively in alatae.

From all these species the new species also differs in its host association. It is unusual of the *Chaitophorus* species to live on a plant of family Myrtaceae, the usual host being the plants of Salicaceae. Another interesting feature is the find of the new species in a coastal state of estern India. Before this the genus was known to be represented in the hills of North India only (Ghosh, 1980).

The new species may be taken as a close relative of *C. pakistanicus* H. R. L. which is present in the northern Himalayas on *Salix*. Of other two allied species, *C. horii* Takahashi is a palearctic

species (Higuchi, 1972) and *C. populeti* (Panzer) is predominantly a palearctic species with a recent record from India (Chakrabarti, 1977).

Acknowledgements: The authors are thankful to the University Grants Commission, New Delhi for the financing the project, the Head of the Department of Zoology, Calcutta University for laboratory facilities.

REFERENCES

Chakrabarti, S. (1977) Chaitophorinae (Aphididae : Homoptera) of India with descriptions of three new species from Northwest India. *Orient. Insects*, **11** (2), 205—224.

Ghosh, A. K. (1980) *The Fauna of India and the adjacent countries. Homoptera, Aphidoidea.* Part I. *General introduction and subfamily Chaitophorinae.* Manager of Publication, Govt. of India, Delhi, 124 pp.

Higuchi, Hiromichi (1972) A taxonomic study of the subfamily Callipterinae in Japan (Homoptera : Aphididae). *Insecta matsum.*, **35** (2), 19—126.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 13 *to* 17

NEW AND HITHERTO NOT KNOWN SPECIES OF APHIDS (HOMOPTERA: APHIDIDAE) PRODUCING LEAF GALLS IN THE NORTH WEST HIMALAYAS, INDIA

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(Received 21 June 1982)

This paper embodies the description of one new species viz., *Cryptaphis garhwalensis* sp. nov. and records of 4 species viz., *Eumyzus impatiensae* (Shinji), *Hamamelistes miyabei* (Matsumura), *Myzus formosanus* Takahashi and *Tetraneura (Tetraneura) ulmi* (Linnaeus) which are new to India. Besides, hitherto undescribed apterous oviparous female of *Hamamelistes miyabei* (Matsumura) has also been described from North West Himalayan region. The nature of galls produced by these aphids has been described.

(*Key words:* aphids, taxonomy, aphid galls, new species, new records, undescribed morph, North West Himalayas, India)

1. **Cryptaphis garhwalensis** sp. nov. (Figs. 1A-D)

Apterous viviparous female: Body 2.08-2.42 mm long with 1.37-1.43 mm as maximum width. Head pale brown, with very poorly developed lateral frontal tubercles; dorsum little scabrous with 5 pairs (one specimen with 11) of long and stout hairs with capitate apices arise from low but distinct tuberculate bases; longest one on vertex about 92-103 μm long and 3.12-3.50 times as long as basal diameter of antennal segment III. Antennae darker apically, about 0.68-0.86 times the body; segment III smooth, rest of the flagellum gradually and distinctly imbricated apicad hairs on the flagellum thick, distinctly arising from raised bases; segment I with 4 long and 1 short hairs, II with 4 long hairs; hairs on the flagellum more or less of equal size, segment III with 13-15 hairs on inner side; longest one about 66-74 μm long and about 2.25-2.50 times as long as basal diameter of antennal segment III: processus terminalis long about 2.62-3.50 times the base of segment VI and about 0.63-0.80 times the segment III; segment III with 2-4 round secondary rhinaria usually restricted near the basal portion. Rostrum reaches mid coxae, ultimate rostral segment about 1.25-1.30 times as long as second joint of tarsus with 5 pairs of secondary hairs. Thorax pale brown scabrous with scattered spinules both dorsally and ventrally mid-thoracic furca with separate arms. Abdomen pale brown, membranous, dorsum with scattered spinules; dorsal hairs long, stout having slightly expanded to capitate apices, arising distinctly from low tuberculate bases, anterior tergites with 30-34 hairs, longest one about 92-114 μm long and 3.12-3.87 times as long as basal diameter of antennal segment III; tergites 7 and 8 with 10 and 8 hairs, longest one on these tergites about 3.75-4.37 and 3.37-4.12 times as long as the mentioned diameter respectively. Venter with rows

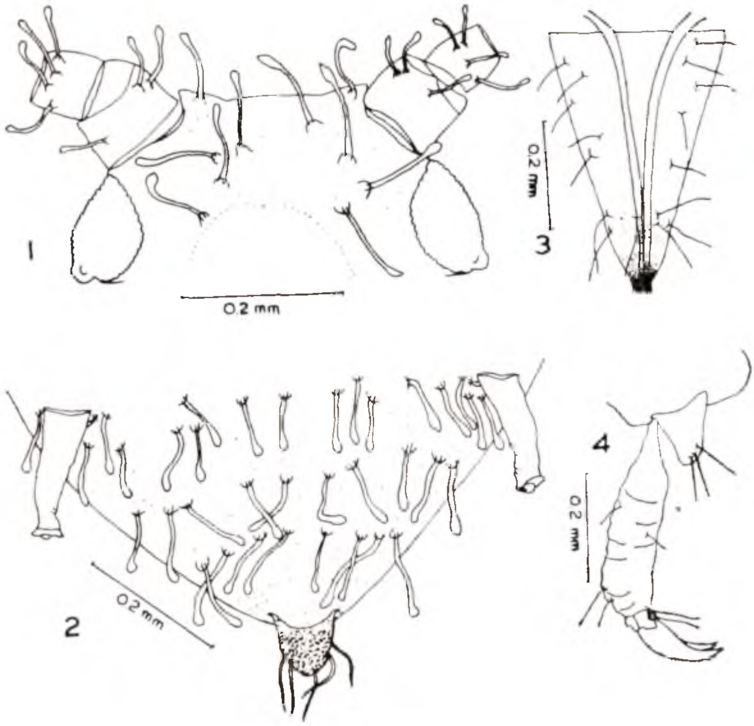

Fig. 1—4. *Cryptaphis garhwalensis* sp. nov. Apterous viviparous female: 1. Head; 2. posterior portion of abdomen; 3. ultimate rostral segment; 4. hind tarsus.

of spinules; ventral hairs shorter, thinner than dorsal hairs and with acuminate to blunt apices. Siphunculi subcylindrical, pale brown, little darker apically, about 0.09-0.10 times the body, nearly smooth or faintly imbricated, little bent inwardly with 1-2 rows of striae near the apex and with a distinct flange. Cauda nearly tongue-shaped and with 5 hairs. Subgenital plate with 4 hairs on the anterior half and 8 hairs on the posterior margin. Legs pale brown, darker apically, femora nearly smooth, femoral and tibial hairs long, stout with expanded to capitate apices; tarsi brown, faintly imbricated, first tarsal chaetotaxy 3, 3, 3.

Measurements of holotype in mm: Body length 2.41, width 1.40; antenna 1.78; antennal segments III: IV: V: VI 0.52: 0.28: 0.25: (0.11+0.41); u. r. s. 0.14; h. t. 2 0.11; siphunculus 0.25; cauda 0.13.

Holotype: Apterous viviparous ♀, INDIA UTTARPRADESH: Ghangaria, 1. vi. 1980 (coll. S. Chakrabarti) from leaf galls of *Lamium album*. **Paratypes**: 4 apterae and nymphs, collection data as in holotype.

Remark: This new species in having antennal segment IV without secondary rhinaria, cauda with 5 hairs, antennal segment III with more or less uniformly long hairs with distinctly capitate apices cones close to *Cryptaphis bromi* Robinson (1967). but it can be separated from *bromi* in having the following characters: slender and longer (0.13-0.14 mm) u. r. s. bearing 5 pairs of secondary hairs (in

bromi 0.10-0. 11 mm, bearing 2-3 pairs of secondary hairs) absence of mid frontal prominence and very poorly developed lateral frontal tubercles (strongly developed in *bromi* and longer (2 25-2.50 times) antennal hairs (maximum upto twice in *bromi*).

Nature of gall: Galls are produced due to curling of leaves with irregular open pockets and with strongly verrucose surface on the dorsal surface of the lamina.

2. **Eumyzus impatiensae** (Shinji)

Aphis impatiensae Shinji, 1924. *Zool. Mag*. 36:355.

Myzus impatiensae Monzen, 1929 *Saito. Ho-on. Kai Monogr.* 1:66 *syn.*

Eumyzus impatiensae (Shinji); Shinji 1929. *Lansonia*, 1:111; paik, 1965. Aphids of Korea, 60; Miyazaki, 1971. *Ins. Matsumurana*, 34:76.

Material studied: 7 apterous viviparous ♀♀ and nymphs, INDIA, UTTAR PRADESH, Trijuginarayan, 8.x 1979 from leaf galls of *Impatiens* sp. (coll. D. K. Bhattacharya).

Remark: This species is recorded for the first time from India.

Nature of gall: Epiphyllous (involute) leaf folding margins fused to form a single tubular structure which is open at both ends and copper red in colour.

3. **Hamamelistes miyabei** (Matsumura, *comb. nov.*

Mansakia miyabei Matsumura. 1917. Collect of Essays for Mr. Y. Nawa, Gifu, 3:59.

Hamamelistes betulinus miyabei (Matsumura); Eastop and Hille Ris Lambers, 1976. Survey of the World's Aphids, 212.

Hamamelistes miyabei (Matsumura) *comb. nov.*

Material studied: 5 apterous viviparous ♀♀, 4 alate viviparous ♀♀, 1 apterous ♀ and nymphs, INDIA, UTTAR PRADESH, Govindghat, 30. v. 1980 from leaf galls of *Betula alnoides* (coll. A. K. Mandal).

Apterous oviparous female: Body about 2.30 mm long with 1.11 mm as maximum width. Head fused with pronotum; anteromedially brown, rest pale, with a median suture; dorsum densely wrinkled bearing 5 pairs of long and stout hairs, mostly with acuminate apices, often with furcated apices; longest one about 1.37 times as long as basal diameter of antennal segment III. Antennae 3 segmented, fuscus brown, scabrous, about 0.07 times the body; segments I and II each with 2 hairs; flagellar hairs thin and fine; processus terminalis about 0.11 times the base of last antennal segment; primary rhinaria ciliated. Eyes 3 faceted, on dark sclerotic rim. Rostrum reaches beyond the fore coxae; ultimate rostral segment about 0.07-0 08 mm long and without secondary hairs Thorax pale, scabrous, bearing huge wax pores; hind-thoracic furca with separate arms, metathorax with a similar furca like structure. Abdomen pale, membranous, densely covered with wax gland cells leaving spinal areas on tergite 1-4 which are with wax pores only; dorsum scabrous with fine spinules specially on the posterior tergites; tergites each with faint brownish sclerotic patches on the spinopleural region which are darker caudad; dorsal hairs long stout, usually with flagellate apices; anterior tergites with 6-8 hairs, longest one about 2.27-2.36 times as long as basal diameter of antennal segment III; 7 and 8 with 4-5 and 4 hairs respectively; longest one on these tergites about 2.45-2.81 times and 2.90-3.18 times as long as the mentioned diameter respectively. Venter spinulose, ventral hairs short, thin and sparse. Siphunculi

ring like on brown chitinised rim. Cauda knobbed, dark, bearing many (16-18) hairs. Subgenital plate with 28 hairs. Legs brown, efmora scabrous; femoral hairs short and fine; tibiae scabrous; first and second legs without tarsi, hind leg with atrophied arsi. Claw and empodium absent.

Measurement of the specimen in mm: Body length 2.30, width 1.11; antenna 0.23; antennal segments I:II:III 0.04:0.04 (0.13+0.001); u. r. s. 0.07.

Remark: According to Pergande (1901), Baker (1920) and Heie (1980) the genus *Hamamelistes* Shimer can be recognised mainly by the following characters from the closely related genera. Absence of siphuncular pore, body not surrounded by a waxy fringe, antennae 3 segmented, legs more or less reduced in over-wintering generations in apterae; in alatae antennae composed of five segments and armed with annular sensoria, media of the fore wing simple and hind wing with both the oblique.

The present material collected from north west Himalayas by its morphological features is quite identical with *Mansakia miyabei* of Matsumura (1917). Eastop and Hille Ris Lambers (1976) regarded *Mansakia* Matsumura and *Hamamelistes* Shimer synonymous and treated *miyabei* Matsumura as a subspecies of *Hamamelistes betulinus* (Horvath). However, presence of ring like siphuncular pore in the apterae of *miyabei* Matsumura both in the present material and also in Japanese ones strikingly separate from *betulinus* (Horvath) in which siphuncular pore is always absent in the apterous morph. Hence in accordance with Eastop and Hille Ris Lambers *(op. cit.)* the present material may be treated as *Hamamelistes* but *miyabei* Matsumura may be considered as separate and distinct species, and not as a subspecies of *betulinus* (Horvath).

Nature of gall: Bivalved, hypophyllous (revolute) leaf folding galls are produced. Leaf blades are heavily thickened, margins are coming in contact with each other leaving a narrow furrow extending along the whole length of the margins.

4. **Myzus formosanus** Takahashi

Myzus formosanus Takahashi, 1923. Aphididae of Formosa I, Part II: 11.

Myzus formosanus Takahashi; Eastop and Hille Ris Lambers 1976. Survey of the World's Aphids, 197.

Material studied: 7 apterous viviparous ♀♀ and nymphs, INDIA, UTTAR PRADESH, Gourikund, 9.x.1979 from leaf galls of *Impatiens? balsamina* (coll. D. K. Bhattacharya).

Nature of gall: Epiphyllous marginal leaf roll galls with thickened leaf blades from a tublar structure on either side of the mid rib and the galls are open at both ends.

5. **Tetraneura (Tetraneura) ulmi** (Linnaeus).

Aphis ulmi Linnaeus, 1758. Syst. nat., Edit X : 451

Tetraneura ulmi (Linnaeus); Koch, 1857. Pfl. Aphiden, 313.

Tetraneura (Tetraneura) ulmi (Linnaeus): Hille Ris Lambers, 1970. *Boll. Zool. agr. Bachic.*, Ser. II, 9: 75.

Material studied: 3 apterous viviparous ♀♀, 6 alate viviparous ♀♀ and nymphs, INDIA, JAMMU & KASHMIR, Srinagar, 22. v. 1979 from *Ulmus wallichiana* (coll. D. K. Bhattacharya).

Nature of gall: Bladder like leaf galls with thick walls are formed always on dorsal surface of the leaf blade. These are usually solitary, reddish, conical and with a very short stalk.

Acknowledgements: The authors express their thanks to Dr. V. F. Eastop, England for his comments on some of the species and to Dr. M. Stoezel, USDA, USA, and Dr. S. Aoki, Hokkaido University, Japan for loan of some *Hamamelistis* material, Head, Dept. of Zoology for providing laboratory facilites.

REFERENCES

BAKER, A. C. (1920) Generic classification of the Hemipterous family Aphididae. *Bull. U. S. Dep. Agric.*, **826**, 1—109.

EASTOP, V. F. & D. HILLE RIS LAMBERS (1976) *Survey of the World's Aphids* Dr. W. Junk b. v. Publishers, The Hague, 1—573.

HEIE, O. E. (1980) The aphidoidea (Hemiptera) of Fennoscandia and Denmark. I. *Fauna Entomologica Scandinavia*, 9, 1—236.

MATSUMURA, S. (1917) *Synopsis of the Pemhigidae of Japan.* Collection of Essays from Mr. Y. Nawa, *Gifu*, 3, 39—94.

PERGANDE, T. (1901) Two species of plant lice inhabiting both the witch-hazel and birch. *U. S. Dep. Ag. Div. Ent. Tech. Ser.* 9, 1—44.

ROBINSON. A. G. (1967) A new genus *Misturaphis*, and a new species of *Cryptaphis* from Manitoba (Homoptera : Aphididae), with a note on *Pseudoasiphonaphis anoglis*. *Can. Entom.*, 99, 565—569.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 19 *to* 22

THE EFFECT OF TEMPERATURE AND HUMIDITY ON DIFFERENT NYMPHAL INSTARS OF *PYRILLA PERPUSILLA* WALKER

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(Received 12 June 1982)

Fifty freshly hatched 1st instar nymphs were kept individually in plastic vials at various combinations of temperature and humidity. Nymphs failed tc develop into successive instars at lowest temperature of 19.8°C with 51-65% humidity and highest temperature of 41.6°C with 50-61% humidity. Mortality was greater in early instars as compared to later ones. Nymphs develop faster at an average temperature of 32.2°C and 61-70% humidity with a high percentage of nymphal mortality. Nymphal duration was longest at an average temperature of 23.4°C and 58-74% humidity. The best combination for development of hymphs was 29.4°C and 75-84% humidity; it had least nymphal mortality. The threshold temperature for the development of nymphs was found to be 10.5°C.

(Key words: effects of temperature, humidity, nymphs, *Pyrilla perpusilla)*

INTRODUCTION

The sugarcane leaf hopper or *Pyrilla* is most destructive pest of sugarcane, widely distributed in the Oriental region. The Indian species *Pyrilla perpusilla* Walker (Lophopidae: Fulgoridae) is a sporadic pest of sugarcane found all over India and adjoining countries. The climatic conditions usually play an important role in governing the activity of pest for which *Pyrilla* is no exception. Several workers in India (MISRA, 1917; RAHMAN & NATH, 1940; QUADRI & AZIZ, 1950; BUTANI, 1964) have studied bionomics of this pest in field and have reported the nymphal duration in different seasons of the year. From the available literature it is clear that no attempt has been made to study the effect of temperature and relative humidity on different nymphal instars under laboratory condition. With this view the experiments were conducted to find out the effect of these environmental factors on different nymphal instars of *P. perpusilla*.

MATERIALS AND METHODS

During present studies, adults of *P. perpusilla* were collected from the field and reared in the laboratory in rearing cages measuring 30 cm × 30cm×40cm. Freshly emerged fifty nymphs were kept in plastic vials (Fig. 1) at following ranges of temperature and humdity; 19.1—21.6°C and 51—65% RH; 21.1—25.2°C and 58—74% RH; 28.5—31°C and 75—84% RH; 30—34.6°C and 61—70% RH and 37—42°C and 50—61% RH. The instars were fed on sugarcane topshoots which were changed daily.

RESULTS

The results obtained (Table 1) show that of the fifty nymphs reared at an average temperature of 23.4°C with 58-74% humidity, 29.4°C with 75-84% humidity and 32.2°C with 61-70% humidity respectively, 13, 34 and 7 adults were obtained. However, nymphs kept at an average higher temperature of 41.6°C and 50-61% humidity only 16% were converted into second instars but later on

TABLE 1. Percentage mortality and duration of nymphal instars at different temperatures and humidities.

Nymphal Instar	Temperature°C	19.1—21.6 (19.8)*	21.1—25.2 (23.4)	28.5—31.0 (29.4)	30.0—34.6 (32.2)	37.0—42.0 (41.6)
	Humidity %	51—65	58—74	75—84	61—70	50—61
Ist	% Mortality	Nymphs died within 3-4 days	28.0	10.0	30.0	84.0
	Nymphal duration in days		8.0	6.0	5.0	3.0
IInd	% Mortality	-do-	18.0	6.0	26.0	16.0
	Nymphal duration in days		8.0	6.0	5.0	—
IIIrd	% Mortality	-do-	14.0	8.0	16.0	—
	Nymphal duration in days		9.0	6.0	6.0	—
IVth	% Mortality	-do-	10.0	6.0	10.0	—
	Nymphal duration in days		10.0	7.0	6.0	—
Vth	% Mortality	-do-	4.0	2.0	4.0	—
	Nympal duration in days		12.0	7.0	6.0	—
% Of nymphs reaching adult stage		0.0	26.0	68.0	14.0	0.0

* Figures in parenthesis represent the average temperatures.

TABLE 2. The rate of development under various thermal conditions

Thermal conditions Tem. °C	Humidity%	1st — 2nd	2nd — 3rd	3rd — 4th	4th — 5th	5th — adult
19.1—21.6 (19.8)*	51—65	Ist Instar died within 3—4 days.				
21.1—25.2 (23.4)	58—74	36/50(72.00)	27/36(75.00)	20/27(74.07	15/20(75.00)	13/15(86.66)
28.5—31.0 (29.4)	75—84	45/50(90.00)	42/45(93.33)	38/42(90.47)	35/38(92.1)	34/35(97.14)
30.0—34.6 (32.2)	61—70	35/50(70.00)	22/35(62.86)	14/22(63.64)	9/14(64.28)	7/9(77.77)
37.0—42.0 (41.6)	50—61	8/50(16.00)	0/8(0.0)			

* Figures in parenthesis represent the average temperatures.

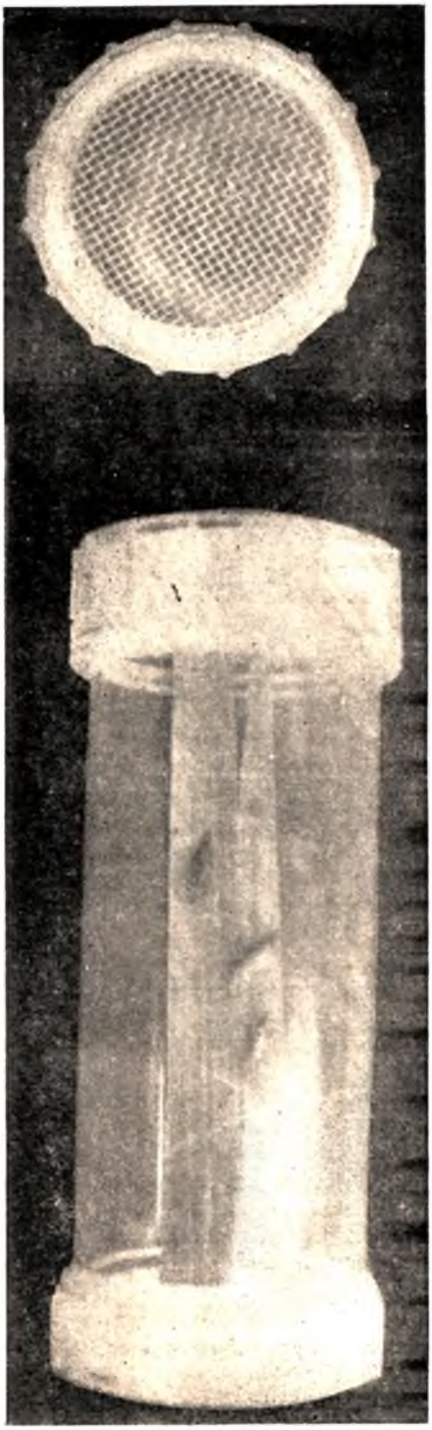

Fig. 1. Plastic rearing vials.

their development ceased. Mortality was highest in the early instar nymphs but in successive instars it gradually decreased at all the combinations of temperature and humidity except at an average temperature of 29.4°C where mortality was lesser in second instars as compared with third instars.

The data also reveal that nymphs developed faster at an average temperature of 32.2°C and 61-70% humidity and took 28 days for their complete development; however, at this range the nymphal mortality was highest i. e., 86% (Fig. 2 A). The nymphal development was completed in 32 days at 29.4°C and 75-84% humidity and at this range the mortality of nymphal instars was the least being only 32% (Fig. 2B). Therefore, this temperature may be regarded as most suitable for the development of nymphs. The development was much more slow at 23.4°C and 58-74% humidity and completed in 47 days with 74% nymphal mortality (Fig. 2C).

The rate of development of different instars at different thermal conditions (Table 2) show that at an average temperature of 23.4°C and 58-74% humidity, more than 70% of insects in each instar moulted to the next stage while at an average temperature of 29.4°C and 75-84% humidity, the development of each instar was above 90%, however, the nymphal development in each instar retarded at an average temperature of 32.2°C and 61-70% humidity.

The threshold temperature for the development of nymphs as established by (Fig. 3) lies at 10.5°C. The values of K at 23.4°C = 606.3, 29.4°C = 604.8 and 32.2°C = 607.6. The values being almost identical suggest that the theoretical threshold of development as determined is approximately correct.

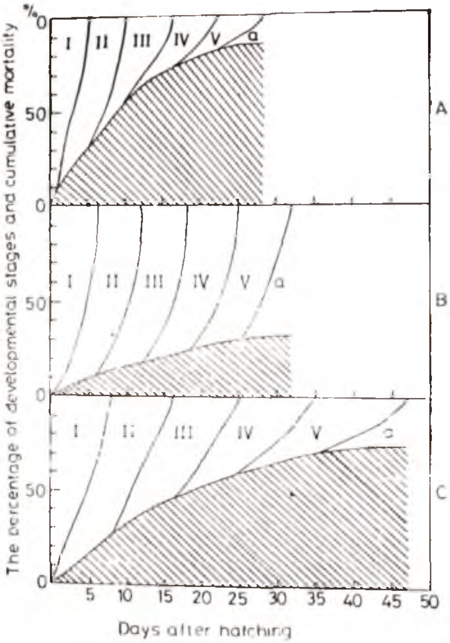

Fig. 2. Growth curve and mortality under different thermal conditions I, II, III, IV, V and 'a' show the respective nymphal instars and adults. Mortality is shown in oblique lines. A: 32.2°C and 61 to 70% humidity B: 29.4°C and 75 to 84% humidity C: 23.4°C and 58 to 74% humidity.

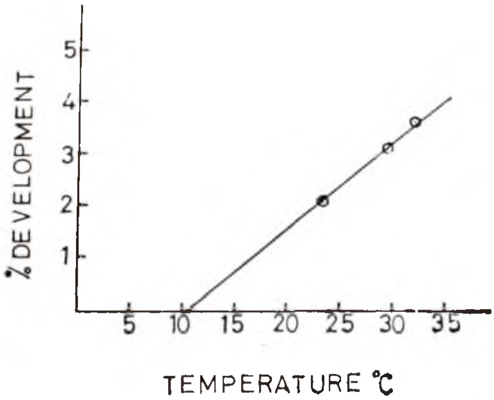

Fig. 3. Effect of temperature on development of *Pyrilla perpusilla* nymphs.

DISCUSSION

The best combination for the development of nymphs was found to be 29.4°C with 75-84% humidity under laboratory conditions. At this combination each nymphal stage was completed in 6-7 days with a total period of 32 days. RAHMAN & NATH (1940) and QUARDI & AZIZ (1950) also found that in the field during rainy season each nymphal stage varied from 7-11 days with a total period of 28-69 days and 6-9 days with a total period 34-40 days respectively. At an average temperature of 32.2°C with 61-60% humidity the duration of nymphal instars varied from 5-6 days with a total period of 28 days but at an average temperature of 23.4°C and 58-74% humidity each nymphal instar took 8-12 days with a total period of 47 days. RAHMAN & NATH (1940) also recorded the longest nymphal period of 103 days during winter in the field condition.

Acknowledgements: The authors are deeply indebted to Dr. S. D. LOIWAL, principal of the college and Dr. O. P. SAXENA, Head of the Zoology Department for providing research facilities. The first author is obliged to the CSIR, New Delhi for the award of Junior and Senior Research Fellowships.

REFERENCES

BUTANI, D. K. (1940) Sugarcane leafhopper *Pyrilla perpusilla* Walker—a review. *Ind. Sug. Jr.*, 9 (1), 60—75.

MISRA, C. S. (1917) The Indian sugarcane leafhopper *Pyrilla aberrans* Kirby. *Mem. Dept. Agric. India (Ent. Ser.)*, 5 (2), 73—133.

QUADRI, M. A. H. & M. A. AZIZ (1950) On Indian Insect types. 2-Biology, life history and external and internal anatomy of *Pyrilla perpusilla* Walker. *Aligarh Musl. University. Pub. (Zool. Ser.)*, 1—33.

RAHMAN, K. A. & R. NATH (1940) Bionomics and control of Indian sugarcane leafhopper *Pyrilla perpusilla* Walker Rhynchota. Fulgo. in Punjab. *Bull. Ent. Res.*, 31, 179—190.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 23 *to* 25

STUDY ON APHID TENDING ANTS IN INDIA - II. NEW RECORDS OF APHID AND ANT SPECIES IN THEIR ASSOCIATION

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(Received 15 January 1982)

Two genera and six species of ants are reported as new records in respect of their aphid association from India. Besides, five species of aphids are reported here as myrmecophilous for the first time.

(*Key words*: new records of ants and aphids in their association)

Further study on the interacting ant and aphid material collected in the area of Sikkim has resulted in the find of 2 genera and 6 species of ants and 5 species of aphids as new records from India in respect of their mutual association. The new records of ant genera have been denoted by single *, those of ant species by two ** and those of aphid species by three ***.

Ant species	Aphid species	Host plant	Place & date	Material examined (workers)	Remarks
Sub family - FORMICINAE ** *Polyrhachis laevissima* Smith, 1858	*Toxoptera aurantii* (B.d.F.)	*Schima wallichi*	Sikkim: Pelling 17.v.78	2	Distributed in Indo-Malayan region (Bingham, 1903). Other known aphid attending ant species of the genus a. *P. dives* Smith Kurl and Mishra, 1980 from Assam. b. *P. simplex* Mayr; Kurl and Misra, 1980 from Rajasthan.

Ant species	Aphid species	Host plant	Place & date	Material examined (workers)	Remarks
Sub family-DOLICHODERINAE *Hypoclinea feae* Emery, 1889	*Aphis craccivora* Koch	Indet. Leguminoseae	Sikkim: Jorethung, 4.v.77	4	Bingham (1903) recorded the distribution of this ant species from Sikkim and Burma
	Aphis gossypii complex	*Duranta plumieri*	Sikkim: Mangan, 30.iv.77	2	
	Aphis spiraecola Patch	*Sida rhombifolia*	Sikkim: Melli, 5.iii.77	3	
	*** *Macromyzus (Anthracosiphoniella) maculetum* (Basu)	Fern	Sikkim: Mangan, 30.xi.76	3	
	*** *Uroleucon sonchi* (Linn)	Indet. Rosaceae	Sikkim: Mangan, 30.xi.76	20	
Sub family-MYRMICINAE ** *Crematogaster flava* Forel, 1886	*Aphis gossypii* complex	*Gossyium* sp.	Sikkim: Melli, 13.xi.76	2	Distribution of this species in India is known from Assam, Sikkim, Orissa and Travancore (Bingham 1903).
	*** *Nippolachnus piri*, Matsumura	*Pyrus, communis*	Sikkim: Namchi, 3.v.77	3	
	*** *Sinomegoura citricola* v. d. Goot	*Piper* sp.	Sikkim: Gayzing, 10.xii.77	2	
** *Monomorium floricola* Jerd, 1851	*Greenidea (Trichosiphum) formosanaheeri* Raychaudhuri, Ghosh, Banerjee and Ghosh	Indet Euphorbiaceae	Sikkim: Singhtam, 2.v.77	2	This species is widely distributed in India (Bingham, 1903).
Rhoptromyrmex wroughtoni Forel 1902	*Aphis spiraecola* Patch	*Sida rhombifolia*	Sikkim: Mangan, 30.iv.77	5	Bingham (1903) recorded the distribution of this species from Western India.

Ant species	Aphid species	Host plant	Place & date	Material examined (workers)	Remarks
	Aphis sp.	Indet. Compositae	Sikkim: Mangan, 27.xi.76	2	
Solenopsis geminata (Fabricina, 1804)	*Aphis gossypii* complex	*Catheranthus rosens*	Sikkim: Singtham, 2.v.77	5	This ant species is well known for attending different aphid species in India (Datta *et al.* in press).
	Aphis sptraecola Patch	Indet. plant	Sikkim: Deoraili, 24.xi.76	5	Present study has widened the association range of this ant species in respect of the aphid species.
	Hysteroneura seteriae (Thomas)	*Saccharum officinarum*	Sikkim: Singtham, 2.v.77	4	Datta *et al.* (In press) discussed the aphid relation ship of this ant species from India.
Tetramorium bicarinatum (Nylander, 1846)	*Lachnus tropicalis* (v. d. Goot)	*Quercus* sp.	Sikkim: Pelling, 17.v.78.	2	present record of *L. tropicalis* in association of *T. bicarinatum* is new to India.
** *Tetramorium christiei* Forel, 1902	*** *Paraaregma orientalis* Agarwala and Raychaudhuri	Indet. Bamboo	Sikkim: Namchi, 9.xii.77	3	This species is known from Sikkim; Darjeeling and Tukvar (Bingham 1903)

Acknowledgements: Thanks are are due to Mrs. R. Mathew, Zoological Survey of India for her kind help in the identification of some of the ant species. Authors also feel obliged to the Head of the department of Zoology for extending the laboratory facilities. Sincere thanks are also extended to Tapan Poddar and Debasish Mitra for their help in preparation of the manuscript.

REFERENCES

BINGHAM, C. T. (190·) *The Fauna of British India, including Ceylon and Burma.* Published under the Authority of The Secretary of State for India in council London, pp. 1-506.

KURL, S. P. & S. D. MISRA (1980) Interaction between the aphids and their attendant ants. *J. Environ. Res.*, 1, 1—6.

DATTA, S. K., D. RAYCHAUDHURI & BASANT K. AGARWALA. Study of aphid tending ants in India - I Entomon, (in press),

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 27 *to* 34

PARASITOIDS AND PREDATORS OF APHIDS (HOMOPTERA : APHIDIDAE) FROM INDIA - VI. NEW RECORDS OF SEVEN ARACHNIDS, ONE DIPTERAN AND ONE NEUROPTERAN PREDATORS FROM HIMACHAL PRADESH, INDIA

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(Received 10 April 1982)

This paper reports 2 aphidids as parasitoids, 13 spiders, 12 coccinellids, 8 syrphids and 1 chrysopid as predators of aphids from Himachal Pradesh, Northwest India. 7 species of spiders, 1 species of syrphid and the species of chrysopid are new records for India. Apart from the above the aphids are recorded as new hosts for the parasitoids and predators.

(*Key words:* Parasitoids and predators of aphids)

This paper reports the parasitoids and predators of aphids of Himachal Pradesh collected during the period 1979—81. Out of the 34 recorded species of predatory components, 21 are insects and 13 are spiders. Insect predators are comprised of 12 coleopterans, 8 dipterans and 1 neuropteran species. Similar studies for aphid parasitoids revealed the occurrence of 2 belonging to the family Aphididiae.

Aphid predators include 9 species as new records for India, Besides, host records for each of the predators and parasitoid species are new for India.

New records for Predators have been denoted by (*) mark.

Examples of the natural enemies, except the parasitoid No. 2 (Presently with Dr. Shuja Uddin) as well as the aphid hosts are in the collection of Entomology Laboratory, Department of Zoology, Calcutta University.

A. PARASITOIDS:

Family : Aphidiidae

Host record for each of the parasitoids mentioned below are further additions to the list of host spectrum of Indian Aphidiidae provided by Agarwala *et al.* (1981 a, b), (Saha *et al.* 1982).

	Parasitoids	Aphid host	Host plants	Locality	Date
1.	*Aphidius smithi* Sharma and Subba Rao	*Amphorophora ampullata bengalensis* Hrl & Basu	Indet fern	Katrain (c 1464 m)	31.viii.80
2.	*Lysaphidus qadrii* Shuja Uddin	*Myzus ornatus* Laing	Indet plant	Simla (c 2000 m)	11.xi.80

B. PREDATORS

Order : ARANEIDA

Agarwala *et al.* (1981a), Battu and Singh (1975), Raychaudhuri *et al.* (1978, 1979) so far recorded 23 species of spiders as the natural enemics of all aphid species from India.

	Parasitoids	Aphid hosts	Host plants	Locality	Date
	Family : Araneidae				
1.	*Araneus* ap.	*Capitophorus formosartemisae* (Tak.)	*Artemisia* sp.	Katrain (c 1464 m)	7.v.80
2*	*Neoscona rumpfi* (Thorell)	*Myzus dycei* Carver	*Urtica purviflora*	Solan (c 1450 m)	14.x.79
3.	*Neoscona* spp.	*Chaitophorus kapuri* Hrl	*Populus* sp.	Manali (c 2050 m)	24.vi.81
		Liosomaphis himalayensis Basu	*Berberis* sp.	do	21.vi.81
		Metopolophium phaseoli (Chakrabarti, Ghosh and Raychaudhuri)	*Spiraea canescens*	do	21.vi.81
		Neomegouropsis dooarsis (Ghosh and Raychaudhuri)	Indet Leguminosae	Mashobra (c 2149 m)	10.xi.80
	Family : Clubionidae				
4.	*Clubiona* sp.	*Aphis gossypii* complex	Indet plant	Manali (c 2050 n)	28.x.79
		Macrosiphoniella sanborni (Gillette)	*Chrysanthemum* sp.	Solan (c 1450 m)	16.vi.79
	Family : Dictynidae				
5.	*Dictyna* sp.	*Chaetosiphon (Pentatrichopus) tetrarhodum* (Walker)	*Rosa* sp.	Jakhu (c 2455 m)	21.x.79
	Family : Tetragnathidae				
6.*	*Eucta javana* Thorell	*Aphis spiraecola* Patch	*Solanum nigrum*	Solan (c 1450 m)	18.vi.79
	Family : Theridiidae				
7.	*Theridion* sp.	*Globulicaudaphis pakistanica* HRL	*Quercus* sp.	Mashobra (c 2149 m)	10.xi.80
		Nippolachnus piri Mats.	*Quercus* sp.	Simla (c 2000 m)	27.vi.81
	Family : Thomisidae				
8.	*Misumena* sp.	*Macrosiphum rosae* (Lin.)	*Rosa* sp.	do	19.vi.79

Predators	Aphid hosts	Host plants	Locality	Date
9.* *Misumenops khandalaensis* Tikadar	*Macrosiphum indicum* Basu	Indet grass	Banikhet (c 1610 m)	1.xi.80
10.* *Oxyptila* sp.	*Myzus ornatus* Laing	Indet plant	Dalhousie (c 2036 m)	10.vi.81
11.* *Philodromus decoratus* Tikadar	*Brevicoryne brassicae* (Lin.)	*Raphanus sativus*	Fagu (c 2510 m)	23.x.79
12.* *Xysticus minutus* Tikadar	*Myzus mumecola* (Mats.)	Indet plant	Kufri (c 2633 m)	11.iv.80
13.* *Xysticus* sp.	*Eutrichosiphum (Neoparatrichosiphum) khasyanum* (Ghosh and Raychaudhuri)	*Quercus* sp.	Dharmasala (c 1435 m)	17.vi.81
	Myzus ornatus Laing	Indet plant	Dalhousie (c 2036 m)	10.vi.81
Order : COLEOPTERA Family : Coccinellidae				
1. *Adonia variegata* (Goeze)	*Aphis spiraecola* Patch	Indet plant	Jogindernagar (c 1296 m)	7.xi.80
Predatory stage—grub and adult	do	do	Kasauli (c 1927 m)	30.iii.80
	do	*Rumex nepalensis*	Simla (c 2000 m)	3.iv.80
	Brevicoryne brassicae (Lin.)	*Raphanus sativus*	Fagu (c 2510 m)	23.x.79
	do	*Brassica* sp.	Solan (c 1495 m)	15.x.79
	Dactynotus sonchi (Lin.)	*Sonchus* sp.	do	16.vi.79
	Hyperomyzus carduellinus (Theobald)	do	do	16.vi.79
	Liosomaphis himalayensis Basu	*Berberis* sp.	Simla (c 2000 m)	1.iv.80
	Macrosiphum rosae (Lin.)	*Rosa* sp.	Solan (c 1495 m)	15.x.79
	Myzus ornatus Laing	*Salvia* sp.	Chail (c 2250 m)	5.xi.79

Predators	Aphid hosts	Host plants	Locality	Date
2. *Coccinella Septempunctata* Linnaeus	*Aphis ruborum longisetosus* Baus	*Rubus elliptiens*	Solan (c 1450 m)	25.iii.80
Predatory stage—grub and adult	*Cavariella aegopodii* (Scopoli)	*Salix* sp.	Kasauli (c 1927 m)	30.iii.80
	do	Indet plant	Simla (c 2000 m)	1.iv.80
	Chaetosiphon (Chaetosiphon) gracilicornis David, Rajasingh and Narayanan	*Rosa* sp.	Kharighat (c 1596 m)	27.iii.80
	Liosomaphis atra HRL	*Valeriana wallichii*	Simla (c 2000 m)	2.iv.80
	Macrosiphum rosaeiformis Das	*Rosa* sp.	Kharighat (c 1596 m)	28.iii.80
	Matsumuraja capitophoroides HRL	*Rosa* sp.	Simla (c 2000 m)	1.iv.80
	Myzus cymbalariae Stroyan	Indet plant	do	1.iv.80
	Myzus dycei Carver	*Urtica* sp.	Kasauli (c 1927 m)	30.iii.80
	Myzus mumecola (Mats.)	Indet plant	*Kufri* (c 2633 m)	11.iv.80
	Myzus ornatus Laing	*Salvia* sp.	Chail (c 2250 m)	5.xi.79
	do	Indet plant	Simla (c 2000 m)	1.iv.80
	Nippolachnus sp.	*Quercus* sp.	Kufri (c 2633 m)	24.x.79
	Tricaudatus polygoni (Narz.)	*Spiraea cantonensis*	Kasauli (c 1927 m)	30.iii.80
3. *Coelophora sexareata* Mulsant	*Indoidiopterus geranii* (Chowdhuri, Basu, Chakrabarti and Raychaudhuri)	Indet plant	Barog (c 1531 m)	27.iii.80
Predatory stage-adult	*Macrosiphum miscanthi* Tak.	Indet plant	do	27.iii.80

Predators	Aphid hosts	Host plants	Locality	Date
4. *Cryptogonus* sp.	*Aphis spiraecola* Patch	*Ipomea* sp.	Solan (c 1495 m)	15.x.79
Predatory stage adult	*Capitophorus formosartemisae* Tak.	*Artemisia* sp.	Chamba (c 726 m)	3.xi.80
	Impatientinum impatiensae dalhousiensis Verma	*Impatiens* sp.	Dalhousie (c 2036 m)	31.x.80
	Pleotrichophorus glandulosus (Kltb.)	*Artemisia* sp.	Chamba (c 726 m)	3.xi 80
	Myzus persicae (Sulzer)	*Ipomea* sp.	Solan (c 1495 m)	15.x.79
5. *Exochomus uropygialis* Mulsant	*Myzus ornatus* Laing	Indet plant	Simla (c 2000 m)	1.iv.80
Predatory stage adult				
6. *Leis? dimidiata* (Fabricius)	*Myzus ornatus* Laing.	*Salvia* sp.	Chail (c 2250 m)	5.xi.79
Predatory stage adult				
7. *Menochilus sexmaculata* (Fabricius)	*Cavariella simlaensis* Chowdhuri, Basu and Raychaudhuri	Indet plant	Kufri (c 2633 m)	11.iv.80
Predatory stage-	*Coloradoa rufomaculata* (Wilson)	*Chrysanthemum* sp.	Solan (c 1450 m)	15.x.79
grub and adult	*Hyadaphis coriandri* Das	Indet plant	do	31.iii.80
	Liosomaphis atra HRL	*Berberis* sp.	do	26.iii.80
8. *Oenopia kirby* Mulsant	*Aphis spiraecola* Patch	*Solanum nigrum*	Palampur (c 1260 m)	6.xi.80
Predatory stage-grub and adult	*Aphis paraverbasci* Chakrabarti	Indet plant	do	6.xi.80
9. *Oenopia luteopustulata* Mulsant	*Myzus persicae* (Sulzer)	*Zinnia elegans*	Simla (c 2000 m)	22.x.79
Predatory stage-grub and adult				

Predators	Aphid hosts	Host plants	Locality	Date
10. *Oenopia sauzeti* Mulsant	*Aphis kurosawai* Tak.	*Artemisia* sp.	Chamba (c 726 m)	2.xi.80
Predatory stage-adult	*Capitophorus formosartemisiae* (Tak.)	do	do	4.xi.80
	Cavariella aegopodii (Scopoli)	*Rubus ellipticus*	Kulu (c 1200 m)	7.iv.80
	Liosomaphis atra HRL	*Berberis* sp.	Solan (c 1450 m)	26.iii.80
	Melanaphis donacis (Passerini)	Indet grass	Chamba (c 726 m)	4.xi.80
11. *Pulus pyrochellus* (Mulsant)	*Capitophorus formosartimisae* (Tak.)	*Artemisia* sp.	do	4.xi.80
Predatory stage-adult				
12. *Scymnus* sp.	*Cavariella aegopodii* (Scopoli)	*Salix* sp.	Kasauli (c 1927 m)	30.iii.80

predatory stage-adult

Order: DIPTERA

Family: Syrphidae

Agarwala *et al.* (1081 a), Agarwala *et al.*, (1982) have listed the host range, distribution of 31 syrphid species from India. *Syrphus vitripennis* Meigen is being reported here as a new aphidophag us insect from India.

1. *Betasyrphus sera ius* (Weidmann)	*Aphis verbasci* Schrank	*Verbascum thapsus*	Solan (c 14:0 m)	15.xi.79
	Doraphis populi (Maskell)	*Populus* sp.	Manali (c 2050 m)	24.vi.81
	Myzakkata verbasci (Chowdhuri, Basu, Chakrabarti and Raychaudhuri)	*Rubia cardifolia*	Dharmasala (c 1435 m)	do
	Myzus dycei Carver	*Urtica* sp.	Jakhu (c 2455 m)	12.xi.80
2. *Episyrphus balteatus* (de Geer)	*Indoidiopterus geranii* (Chowdhuri, Basu, Chakrabarti aad Raychaudhuri)	Indet plant	Barog (c 1531 m)	27 iii.80
	Macrosiphum miscanthi Tak.	Indet plant	do	do
3. *Ischiodon scutellaris* (Fabricius)	*Aphis punicae* Passerini	Indet plant	Solan (c 1450 m)	26.iii.80
	Metapolophium rubi (Narz.)	*Rubus ellipticus*	do	do

Predators	Aphid hosts	Host plants	Locality	Date
4. *Metasyrphus confrater* (Wiedman)	*Dactynotus simlaensis* (Chakrabarti, Ghosh and Raychaudhuri)	Indet plant	do	26.iii.80
5. *Paragus tibiallis* (Fallen)	*Brachycaudus (Thuleaphis)*	Indet plant	Manali (c 2050 m)	24.vi.81
	rumexi colens (Patch *Metopolophium phaseoli* (Chakrabarti, Ghosh and Raychaudhuri)	*Stephania harnandifolia*	Chamba (c 726 m)	13.vi.81
6. *Scaeva selenitica* (Meigen)	*Metopolophium rubi* (Narz.)	*Rubus ellipticus*	Solan (c 1450 m)	26.iii.80
7.* *Syrphus vitripennis* Meigen	*Myzus dycei* Carver	*Urtica* sp.	Jakhu (c 2455 m)	12.xi.80
8. *Xanthograma* sp.	*Metopolophium rubi* (Narz.)	*Rubus ellipticus*	Solan (c 1450 m)	26.iii.80

Order: NEUROPTERA
Family: Chrysopidae

The species is known to feed on 8 species of aphids in Taiwan (Tao and Chiu, 1971). Earlier Atwal and Sethi, (1963), Behura (1963, 1965), Ghosh *et al.* (1981), Rahman (1940) and Rao (1969) reported this genus from India as aphidophagous.

1.* *Chrysopa septempunctata* Wesmael	*Aphis gossypii* complex	Indet plant	Dharmasala (c 1435 m)	17.vi.81
	Myzus ornatus Laing	Indet plant	Dalhousie (c 2036 m)	10.vi.81

Acknowledgements: Heartfelt thanks are to Dr. P. Stary of Czechoslovak Institute of Entomoogy, Prague; Dr. Shuja Uddin, Department of Zoology, Aligarh Muslim University, Uttarpradesh, India for commenting on the aphid parasites and Zoological Survey of India for comments on the identity and to University Grants Commission for financial assistance. Sincere thanks are extended to Dr. B. K. Agarwala, Calcutta University, Agartala, Tripura for kindly going through the manuscript and to the Head of the Department of Zoology for providing laboratory facilities.

REFERENCES

AGARWALA, BASANT K., D. GHOSH, S. K. DAS, S. C. PODDAR & D. N. RAYCHAUDHURI (1981a) Parasites and predators of ophids (Homoptera : Aphididae) from India-V. *Entomon*, 6 (3), 233—238.

AGARWALA BASANT, K., D. RAYCHAUDHURI & D. N. RAYCHAUDHURI (1981 b) A conspectus of Aphidiid (Hymenoptera : Aphidiidae) parasites of aphids (Homoptera : Aphididae) in India. *Akitu*, n. s. 39, 1—16.

AGARWALA, BASANT K., LASKA, PAVEL & D. N. RAYCHAUDHURI (1982) Prey records of aphidophagous syrphids from India (Diptera : Syrphidae). *Acta Ent.* (in press).

ATWAL, A. S. & S. L. Sethi (1963) Predation by *Coccinetla septempunctata* L. on the cabbage aphid, *Lipaphis erysimi* (Kalt.) in India. *J. Ecol.*, 32, 481—488.

BATTU, G. S. & BALRAJ SING (1975) A note on spiders predating on the insect pests of cotton. *Sci. Cult.* **41** (5), 212—214.

BEHURA, B. K. (1963) Aphids of India : A survey of published information. Proc. First Summer School of Zoolog (Simla 1961), pp. 25—78.

BEHURA, B. K. (1965) Supplement to "aphids of India - a survey of published information". I. *J. Utkal Univ. (Sc.)*, Bhubaneswar, **3** (1), 40—65.

GHOSH, D., S. C. PODDAR & D. N. RAYCHAUDHURI (1981) Natural enemy complex of *Aphis craccivora* Koch and *Lipaphis erysimi* (Kalt.) in and around Calcutta. *Sci. Cult.*, **47** (2), 58—60.

RAHMAN, K. A. (1940) Important insect predators of India. *Proc. Ind. Acad Sci. Bangalore*, **12B** (3), 67—74.

RAO, V. P. (1969) Survey for natural enemies of aphids in India. Final technical report. *Comm. Inst. Biol. Control., Indian Station, Bangalore*, India, pp. 1—93.

RAYCHUDHURI, D. N., S. DUTTA, BASANT K. AGARWALA, D. RAYCHAUDHURI & S. K. RAHA (1978) Some parasites and predators of aphids from northeast India and Bhutan, *Entomon*, **3** (1), 91—94.

RAYCHAUDHURI, D. N., S. DUTTA, B. K. AGARWALA, S. K. RAHA & D. RAYCHAUDHURI (1979) Some parasites and predators of aphids in northeast India and Bhutan-II. *Entomon*, **4** (2), 164—166.

SAHA, J. L., S. C. PODDAR, S. K. DAS, B. K. AGARWALA & D. RAYCHAUDHURI (1982) Studies on the aphid parasites (Hymenoptera : Aphidiidae) from Himachal Pradesh, India *Akitu* (accepted).

TAO, CHIA-CHU & SHUI-CHENCHIU (1971) Biological control of citrus vegetables and tobacco aphids. *Taiwan Agr. Res. Inst., Specl. publ.*, **10**, pp. 1—110.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 35 *to* 39

PARASITES AND PREDATOS OP ROSE INFESTING APHIDS (HOMOPTERA : APHIDIDAE) IN INDIA

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Present study reveals four parasitoids and twelve predators of *Microsiphum rosae* and *M. (Sitobion) rosaeiformis* infesting rose plants in kalimpong.

(Key words: parasitoids, predators, rose aphids)

In India common rose plants are infested by two closely related aphid species viz. *Macrosiphum rosae* (L). and *M. (Sitobion) rosaeiformis* Das. These two aphids exhibit overlapping life colour and very often form common colonies (Agarwala and Raychaudhuri, 1981) *M. rosae* is widely distributed species whereas *M. (S.) rosaeiformis* is restricted in the region of Indian subcontinent (David, 1975).

This paper presents the observations on the parasitoids and predators of the aforesaid two aphid species at Kalimpong, Darjiling district of West Bengal during the period 1977—'78.

In between November 1977 and June 1978 at one month interval 10 aphid colonies of *M. rosae* and *M. (S). rosaeiformis* were observed in their natural condition for the occurrence of parasitoids and predators. At each observation part of these colonies were broght to the laboratory for the rearing of mummified aphids and immature stages of predators. The adult specimens, thus reared, were preserved suitably. Parasiroids were identified by Dr. P. Stary, Czechoslovakia and some of the predators were commented upon by Zoological Survey of India, Calcutta.

As a result of present study, four parasitoids and twelve predators of *M. rosae* and *M. (S.) rosaeiformis* infesting rose plants in India have become known. Table 1 provides data on individual parasitoids and predators in respect of their aphid host/prey, host plant, place, date and necessary remarks. A discussion follows incorporating their relative occurrence and relevant informations.

Spectrum of parasitoids and predators of rose infesting aphids in India

Parasitoids/ predators	Aphid host/prey	Host plant	Place	Date	Remark
Family Aphelinidae					
1. *Aphelinus* sp.	*M. rosae* *M. (S.) rosaeiformis*	*Rosa* sp.	Kalimpong	May 1978	First record from India,

Parasitoids/ predators	Aphid host/prey	Host plant	Place	Date	Remark
Family Aphidiidae					
2. *Aphidius rosae* Haliday	*M. rosae* *M. (S.)rosaetformis*	*Rosa* sp.	Kalimpong	Nov., 1977-June, 1978	Most common parasitoid of rose aphid (Stary, 1961 & 1973)
3. *Ephedrus plagiator* (Nees)	*Myzus persicae*	*Solanum nigrum*	,,	May, 1978	Stary (1976) and Stary & Schelinger (1967) recorded this parasitoid on *M. rosae* in Mediterranean and Far East Asia.
4. *Indaphidius curvicaudatus* Stary	*M. (S.) rosaeiformis*	*Rosa* sp.	,,	Dec., 1977	Stray (1979) opined that it can be an accidental case of parasitization on rose aphid.
	Mollitrichosiphum alni	*Alnus nepalensis*			
Family Coccinellidae					
5. *Chilochorus rubidus* Hope	*M. rosae* *M. (S.) rosaeiformis*	*Rosa* sp.	,,	May, 1978	seem to be casual predator of aphid
6. *Coccinella septempunctata* (L.)	*Aphis craccivora*	*Dolichos lablab*	,,	Nov., 1977-June, 1978	Most common predator of aphids.
	A. gossypii	*Capsicum frutescens*			
	Brachycaudus helichrysi	*Prunus persica*			
	M. rosae *M. (S.) rosaeiformis*	*Rosa* sp.			
	Myzus persicae	*Solanum nigrum*			
	Toxoptera aurantii	*Schima wallichii*			
7. *Coelophora sexareata* Mulsant	*M. rosae*	*Rosa* sp.	,,	April, 1978-May, 1978	Prevalent during summer
	M. (S.) rosaeiformis	,,			
	M. alni	*A. nepalensis*			
	Taoia indica	,,			

Porasitoids/ predators	Aphid host/prey	Host plant	Place	Date	Remark
8. *Oenopia kirbyi* Mulsant	*M. rosae* *M. (S.) rosaeiformis*	*Rosa* sp. ,,	,,	Aprli, 1978	Rao (1969) reported this predator feeding on *Aphis solanella* in the same place
9. *O luteopustulata* Mulsant	,,	,,	,,	,,	rarely occurred with *O. kirbyi* on the same plant
Family Syrphidae					
10. *Allograpta javana* (Weidmann)	,,	,,	,,	April, May, 1978	Maggot preferred younger aphid
11. *Betasyrphus serarius* Weid	*A. craccivora* *A. gossypii* *Aulacorthum magnoliae* *M. rosae* *M. (S.) rosaei-formis*	*Dolichos lablab* *Capsicum frutescens* *Sechium edule* *Rosa* sp. ,,	,,	Nov., 1977-July, 1978	Most prevalent among syrphid predator of rose aphids
12. *Sphaerophoria scripta* (L.)	*Lipaphis erysimi* *M. rosae* *M. (S.) rosaeformis*	*Brassica nigra* *Rosa* sp. ,,	,,	Nov., 1977-January 1978	this predator occurred when other predatory species were absent in the aphid colony
Family Araneidae					
13. *Araneus* sp.	*M. rosae* *M. (S.) rosaeformis*	*Rosa* sp. ,,	,,	Dec., 1978	only juvenile form was found feeding on aphid
14. *Neoscona nautica* (Koch)	,,	,,		March, 1978-May, 1978	olny casual predator of aphid
15. *Rhene khandalaensis* Tikader	,,	,,	,,	,,	,,
16. *Thomisus* sp.	,,	,,	,,	,,	,,

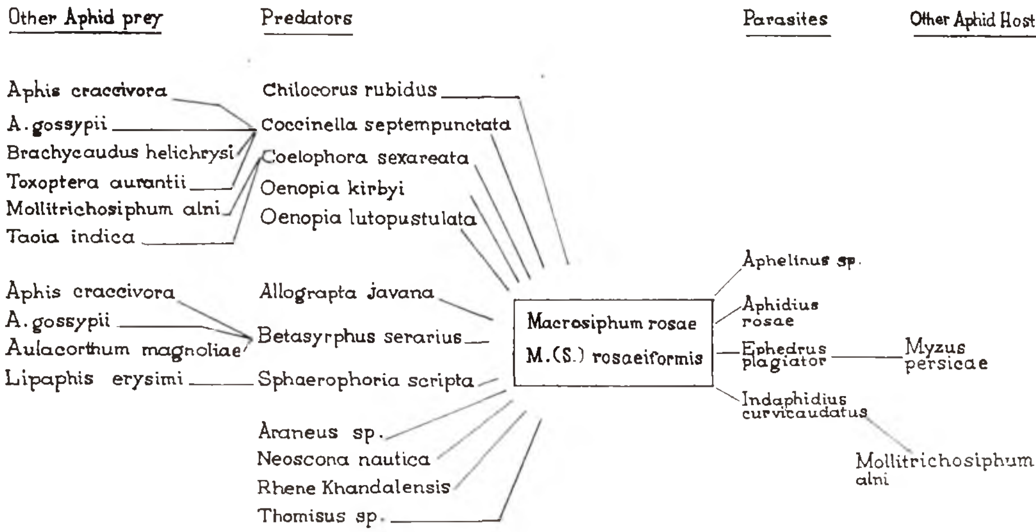

Fig. 1. Parasites and predatorr of *Macrosiphum rosae* and *M. (Sitobion) rosaeiformis.*

Parasitoids of rose aphids in India comprises of 4 species (Fig. 1). Of these *Aphidius rosae* is the chief parasitoid specifically parasitizing rose aphids. This parasitoid appears at the inception of aphid colony on rose plants and its activity continues until the rose aphid population declines considerably. Agarwala and Raychaudhuri (1981) observed that high temperature coupled with high relative humidity favour the incidence of this parasitoid species. *Ephedrus plagiator* is a well known parasitoid of *Lipaphis erysimi* and *Myzus persicae.* Its association with rose ap·id was not known earlier from India. Interestingly this parasitoid visited rose aphids at its peak population in May, 1978 and disappeared in the following month after decline in aphid population. In contrast this parasitoid occurred with *Myzus persicae* on a persisting basis. It appears that rose aphids are newly aquired host of *E. plagiator*. *Aphelinus* sp. and *Indaphius curvicaudatus* seem to be casual parasitoid of rose aphid as their incidence of parasitization of rose plant was very low and for a brief period only.

Predatory complex of rose aphids comprised of 12 species. These included 5 species of coccinellid beetles, 3 species of syrphid flies and 4 species of spiders. Coccinellids were more prevalent than any other predatory group and occurred throughout the life of aphids on rose plants. Syrphid flies appeared late in the aphid colonies and disappeared when the aphids were still on the plant. Spiders were, however, only casual predator of aphids and their incidence was lowest among the predators. *Coccinella septempunctata* was found to be chief predator of rose aphids. This species occurred throughout the length of observation in present study and its incidence was highest

Further detailed study is required for. a better understanding of ecological relationship between the rose aphids and their parasites and predators in order to think of a possibility of biological control of *M. rosae* and *M.* (*S.*) *rosaeiformis.*

Acknowledgement: The author expresses deep sense of gratitude to late Professor D. N. Raychaudhuri for encouragement in pursuing this work. Thanks are also due to Indian council of Agricultural Research and University Grants Commissicn, New Delhi for partly financing the work. The Incharge, Deptt. of Life Science deserve thanks for laboratory facilities.

REFERENCES

AGARWALA, BASANT K. & D. N. RAYCHAUDHURI (1981) Observation on the population trends of rose aphids (Homoptera : Aphididae) in Kalimpong, West Bengal, India. *Entomon*, **6** (3), 213—216.

DAVID, KANAKRAJ S. (1975) A taxonomic review of *Macrosiphum* (Homoptera : Aphididae) in India. *Oriental Ins.* 9 (4) 461—493.

RAO. V. P. (1969) Survey for natural enemies of aphids in India, *CIBC, U. S. PL 480 Project : Final Tach. Report*, 1—93.

STARY, P. (1961) Notes on the Aphididae of of Southern Crimea. *Acta Faunistica Entomologica musci nationalis prague* **7** (63), 129—130.

STARY, P. (1973) A review of the *Aphidius* species (Hymenoptera, Aphididae) of Europe. *Aunotationes Zoologicae et botanicae* **84**. 1-85.

STARY, P. (1976) *Aphid parasites (Hymenoptera: Aphidiidae) of the mediterranean area.* Dr. W. Junk Publishers, hague. 1—92.

STARY, P. (1979) *Indaphidius curvicaudatus* gen. n., sp. n. (Hymenoptera, Aphididiidae), an aphid parasitoid from India. *Acta Entomologica bonemoslovaca*, **76**, 34—37.

STARY, P. & EVERT I SCHELINGER (1967) *A revision of the Far East Asian Aphidiidae Hymenoptera)*, Dr. W. Junk Publishers, Hague. 1—197.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 41 *to* 45

INFLUENCE OF FOLIAR APPLICATION OF INSECTICIDES ON THE RESURGENCE OF BROWN PLANTHOPPER, *NILAPARVATA LUGENS* (STAL) IN RICE[1]

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Studies were taken up to evaluate the reproductive rate and feeding activity of brown planthopper under the influence of foliar insecticides. It was observed that plants treated with decamethrin, methyl parathion, quinalphos, cypermethrin, permethrin and fenvalerate enhanced the reproductive rate of brown planthopper. The reproductive rate was also found to be influenced by the number of insecticide sprays.

(*Key words:* foliar application, insecticide, resurgence, brown planthopper, *Nilaparvata lugens* (Stal)

INTRODUCTION

In recent years, the brown planthopper, *Nilaparvata lugens* (Stal) on rice has become the most important pest in many Asian countries. Control of this pest has primarily depended on the application of broad spectrum insecticides. Of late, control of this pest through the use of insecticides has led to the problem of resurgence (STAPLEY *et al.*, 1977). Eventhough resurgence of brown planthopper has been reported following the application of insecticides, the exact reasons are yet to be documented. It is presumed to be due to a combination of factors such as (a) failure of spray to reach the plant bases where the hoppers feed; (b) Decrease in populations of natural enemies; (c) changes in chemical nature of the plant and (d) stimulation by the insecticides for feeding and oviposition by the planthopper. The present study was designed to evaluate the reproductive rate and feeding activity of brown planthopper under the influence of insecticides.

MATERIAL AND METHODS

Influence of foliar sprays on the reproductive rate and sex ratio of brown planthopper: Ten day old TN-1 seedlings were planted in clay pots (12 cm) at the rate of two seedlings per pot. Spray fluids were prepared from the commercial formulations of emulsifiable concentrates at 0.04% concentrations. The potted plants were sprayed on 30 and 40 days after planting. Plants in each pot were covered with cylindrical mylar film cages. There were nine treatments with three replications. Ten days after last spraying, two gravid females collected from an isogenic culture maintained separately were released per pot and confined for seven days. The reproductive rates were assessed by counting the cumulative number of nymphs that emerged from plants treated with insecticides over a period of ten days.

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For computing sex ratio, the nymphs were reared on the same plants. From this fifty adults were taken at random in each treatment and adults of each sex counted. The resurgence ratio was computed by dividing the mean number of brown planthopper nymphs in each treatment by the mean number of nymphs in the untreated check.

Number of insecticide sprays and brown planthopper resurgence: Potted TN-1 plants of ten days age were used in this study. Forty days after planting a single spray was given. There were twelve treatments with three replications. Ten days after spraying two gravid females were released and confined by using mylar film cages. Their reproductive rates were assessed by counting the number of nymphs emerged.

In another experiment, three sprays were given at 20, 30 and 40 days after planting. Ten days after third spraying, two gravid females were released per plant and covered using mylar cages. Reproductive rate was assessed by counting the number of nymphs emerged.

Insecticide sprays and feeding rate by brown planthopper: The feeding rate of brown planthopper as influenced by insecticide sprays on rice plants was assessed by measuring the area of honeydew excreted by the hoppers. The technique developed by SOGAWA & PATHAK (1970) was modified and employed for this experiment.

The experiment consisted of twelve treatments and three replications. The potted plants were sprayed with the test insecticides on 20 and 30 days after planting. Ten days after second spraying a circular mylar film disc (8.0 cm dia) was placed around the culm and postioned above the water level and Whatman No: 1 filter paper was placed over the mylar film disc. Potted plants were covered using cylindrical mylar film cages of 15.0 cm lengths and 5.0 cm dia. These cages were made to rest over the filter paper. The upper portions of the cylindrical cages were covered using circular film disc. Gap, if any, between the plant and the centre at the circular disc at the top was plugged with cotton wads.

Five fifth instar brown planthopper nymphs were released on each plant and confined inside the cylindrical cages for 24 h. The honeydew excreted by the insects was absorbed by the filter paper. The filter paper was removed after 24 hr and was then sprayed with 0.001% ninhydrin in acetone using an all glass atomizer and oven dried at 100°C for 5 min. The ninhydrin positive spots in each treatment were measured and used as a feeding index. The data were analysed statistically.

RESULTS AND DISCUSSION

Resurgence of insect populations following the application of insecticides has been well documented by RIPPER (1956) and PRICE (1975). Resurgence is characterised by an abnormally rapid increase of pest populations, often far exceeding the economic threshold. Among the insecticide tested in the present study, decamethrin, methyl parathion, quinalphos, cypermethrin, permethrin and fenvalerate enhanced the reproductive rate of brown planthopper (Table. 1). In phosphamidon treated plants the nymphal population was less than that of untreated check. In addition to this the study also revealed that the sex ratio and resurgence ratio were in favour of a resurgence inducing insecticide and were also positively correlated.

It was interesting to note that the reproductive rate of planthopper was found to be influenced by the number of insecticide sprays given. With a single spray the maximum nymphal emergence was recorded in methyl parathion treated plants followed by plants treated with decamethrin. All other treatments registered a lower nymphal population than that of untreated check (Table 2). However, decamethrin, methyl parathion, quinalphos, cypermethrin, permethrin, fenvalerate and fenthion registered significant increase in nymphal population over that of untreated check with two sprays (Table 1). Foliar application of insecticides thrice to the potted plants increased the brown planthopper population in decamethrin, methyl parathion, permethrin, fenthion, cypermethrin and

TABLE 1. Influence of foliar insecticides[1] on the reproductive rate, sex ratio and resurgence ratio of brown planthopper, *Nilaparvata lugens*

(Mean of three replications)

S. No.	Treatments[2]	Number of nymphs emerged in ten days[3]	Sex ratio 0 : 0	Resurgence ratio
1.	Decamethrin (Decis 2.5EC)	285.67 a	1 : 1.63	2.24
2.	Methyl parathion (Metacid 50EC)	245.67 a	1 : 1.58	1.93
3.	Quinalphos Ekalux (25EC)	210.00 bc	1 : 1.46	1.65
4.	Cypermethrin (Cymbush 25EC)	196.67 bcd	1 : 1·44	1.54
5.	Permethrin (Ambush 50EC)	169.67 cde	1 : 1.40	1.33
6.	Fenvalerate (Sumicidin 20EC)	152.67 de	1 : 1.26	1.19
7.	Fenthion (Lebaycid 100EC)	138.67 e	1 : 1.19	1.09
8.	Untreated check	127.33 e	1 : 1.00	—
9.	Phosphamidon (Dimecron 100EC)	126.67 e	1 : 0.92	0.99

1. Two sprays were given at 20 and 30 days after transplanting (DAT).
2. All insecticides were applied at 0.04% and pyrethroids at 0.002%.
3. Means followed by a common letter are not significantly different at 5% (DMRT).

TABLE 2. Influence of foliar insecticides[1] on reproductive rate of brown planthopper, *Nilaparvata lugens*.

(Mean of three replication)

S. No.	Treatments[2]	Number af nymphs emerged in ten days[3]	Resurgence ratio
1.	Methyl parathion (Metacid 50EC)	147.33 a	1.36
2.	Decamethrin (Decis 2.5EC)	120.00 ab	1.10
3.	Untreated check	108.67 bc	—
4.	Fenvalerate (Sumicidin 20EC)	87.00 bcd	0.80
5.	Quinalphos (Ekalux 25EC)	79.00 cd	0.73
6.	Permethrin (Ambush 50EC)	74.33 de	0.68
7.	Phosalone (Zolone 35EC)	60.67 de	0.56
8.	Fenthion (Lebaycid 100EC)	60.00 de	0.55
9.	BPMC 24EC	56.33 de	0.52
10.	Methamidophos (Tamaron 50EC)	41.66 e	0.38
11.	FMC 35001 24EC	35.22 e	0.33
12.	Phosphamidon (Dimecron 100EC)	34.00 e	0.31

1. A single spray was given at 40 DAT.
2. All insecticides were applied at 0.04% and pyrethroids at 0.002%.
3. Means followed by a common letter are not significantly differen at 5% (DMRT).

TABLE 3. Influence of foliar insecticides[1] on the reproductive rate of brown planthopper, *Nilaparvata lugens*.

(Mean of three replications)

S. No.	Treatments[2]	Number of nymphs emerged in ten days[3]	Resurgence ratio	Area of honeydew (sq mm)
1.	Decamethrin (Decis 2.5EC)	240.00 a	1.88	212.67 a
2.	Methyl parathion (Metacid 50EC)	188.33 ab	1.48	199.67 ab
3.	Permethrin (Ambush 50EC)	162.67 bc	1.28	159.67 abc
4.	Fenthion (Lebaycid 100EC)	154.33 bc	1.21	134.00 bcd
5.	Cypermethrin (Cymbush 25EC)	136.67 bc	1.07	132.67 bcd
6.	Quinalphos (Ekalux 25EC)	135.33 bc	1.06	126.00 cde
7.	Untreated check	127.33 cd	—	101.33 cde
8.	Fenvalerate (Sumicidin 20EC)	124.33 cd	0.98	85.33 de
9.	Phosphamidon (Dimecron 100EC)	114.33 cd	0.89	81.33 de
10.	BPMC 24EC	89.33 d	0.70	68.00 d
11.	FMC 35001 24EC	76.67 d	0.60	64.00 de
12.	Methamidophos (Tamaron 50EC)	75.00 d	0.59	55.67 e

1. Three sprays were give at 10, 20 and 30 DAT.
2. All insecticides were applied at 0.04% and pyrethroids at 0.002%.
3. Means followed by a common letter are not significantly different at 5% (DMRT).

quinalphos (Table 3). It was evident that the two sprays were significantly better than a single spray or three sprays in increasing nymphal population. The feeding rate was high in plants treated with decamethrin, methyl parathion, quinalphos, cypermethrin, fenthion, and permethrin (Table 3). In contrast to this in fenvalerate, phosphamidon, BPMC, FMC 35001 and methamidophos treated plants the feeding rate was lower than that of untreated check.

From the results of the present study it can be summarized that direct stimulation in the reproduction of brown planthopper by insecticides can result in its 'flare-back' or 'resurgence'. ROAN & HOPKINS (1961) opined that sub-lethal doses of toxicants might excite the nerve activity and could bring about a favourable neurohormonal influence of the insect reproduction. Further, evidences were also presented that insecticide residues in host plants or at sub-lethal doses caused stimulation in the reproduction and survival of phytophagous insects and mites (DITTRICH *et al.*, 1974).

Acknowledgement: The senior author wishes to thank M/S Sandoz (India) Ltd., Bombay for their financial help during this study.

REFERENCES

DITTRICH, V., P. STREBERT & P. A. BATHE (1974) An old case reopened: Mite stimulation by insecticide residues. *Env. Ent.*, 3, 534—540.

PRICE, P. W. (1975) *Insect Ecology*. John Willy & Sons, N. Y., 514 pp.

RIPPER, W. E. (1956) Effect of pesticides on balance of arthropod populations. *A. Rev. Ent.*, 1, 403—408.

ROAN, C. C. & T. L. HOPKINS (1961) Mode of action of insecticides. *A. Rev. Ent.*, 6, 333—346.

SOGAWA, K. & M. D. PATHAK (1970) Mechanism of brown plant hopper resistance in Mudgo variety of rice (Hemiptera ; Delphacidae). *Appl. Ent.*, 6, 145—158.

STAPLEY, J. H., Y. Y. JACKSON & W. G. GOLDEN (1977) Observation in the Solomon Island on the control of the brown planthopper, *Nilaparvata lugens* (Stal), 375 pp. *In Brown Plant hopper: threat to rice production in Asia*. RRI, Los Banos, Philip pines, 375 p.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 47 *to* 51

ANALYSIS OF WING VIBRATION OF MOSQUITO *ANOPHELES STEPHENSI*

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The paper analyses the wing beat frequency of mosquito *(Anopheles stephensi)*. Different theories for wing beat frequency are discussed. The calculated values of wing beat frequency by mass flow theory are in good agreement with those determined experimentally by acoustic technique. Wing beat frequency of the insect ranges from 400 to 600 Hz. Fourier analysis of flighr sound is undertaken to understand the complexity of the wing motion. The flight tone of *A. stephensi* contains three harmonics. The third harmonic is prominent, not the fundamental.

(Key words: wing beat frequency, flight-sound, mass flow theory, Fourier analysis, wing kinematics)

INTRODUCTION

A perusal of the literature reveals that the information on the frequency of wing beat in small size and high wing beat fliers like mosquito is meagre except the reports of SOTAVALTA (1952) and KAHN & OFFENHAUSER (1949) on *Aedes aegyptii.*

In the present investigation an attempt has been made to study the frequency of wing vibration of high frequency flier, mosquito *(Anopheles stephensi)*. Wing beat frequency is determined experimentally by using acoustic technique. Harmonic oscillator theory, Grawford's relation and mass flow theory are compared to show the validity of mass flow theory in the case of small size and high frequency flier. Fourier analysis is undertaken in order to understand the complexity of the wing motion.

THEORETICAL ASPECTS

According to GREENEWALT (1960) the insects and birds can be considered as mechanical oscillators and hence a differential equation can be set-up, the solution of which is as:

$$\omega^2 = \frac{K b_0 r^2}{I}$$

where ω = angular frequency

b_0 = length of the unstrained muscle

r = effective radius of attack

and I = sum of the external and interna moments of inertia. On the basis of assumptions on different proportionalities for b_0, r, M and I, a general relation is possible for the frequency of wing beat as:

$$\nu_h \, l^{1.15} = 3540 \text{———————} (1)$$

where ν_h = frequency of wing beat

l = length of the wing in millimeters

CRAWFORD (1971) proposed a relation for the wing beat frequency of a flier based on Newton's laws as:

$$\nu_c = \left(\frac{g}{4\pi \rho}\right)^{\frac{1}{2}} \frac{M_t^{\frac{1}{2}}}{S_w} \text{————} (2)$$

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where S_w = wing swept area

M_f = mass of the flier

ρ = density of air = 1.1×10^{-3} g/cc

On the other hand mass flow theory (PURANIK *et al.*, 1977) reveals that when a flier is in the state of hovering, the system is said to be in a dynamical equilibrium which is achieved by the flier by generating a reacting force to just overcome its own weight. On this basis, an expression is given as:

$$\nu_m = \left(\frac{2g}{K}\right) \frac{M_f}{S_d B_{eff} \rho}$$

where S_d = disc area

B_{eff} = effective wing breadth

K = proportionality constant = 980 cm/sec

For large insects, birds and bats where wing stroke angle is considerably large (120° to 140°) the wing area (S_w) is approximately equal to disc area (S_d). But it cannot be true of those insects where wing stroke angle is small (about 60°). Hence in the mass flow theory, wing swept area, S_w = Stroke angle $\times$ (wing length)^2 is considered instead of disc area, $S_d = \frac{\pi}{4} \times$ (wing span)^2. Then the relation for wing beat frequency of high frequency fliers (mosquitoes) as in accordance to mass flow theory is,

$$\nu_m = \frac{2 M_f}{K S_w B_{eff}} \rho \qquad \text{———— (3)}$$

MATERIALS AND METHODS

Mosquitoes, *Anopheles stephensi* (Diptera: Culicidae) were collected from Musi river, Hyderabad and experiments were performed on 9 female insects. Body parameters (mass) and wing parameters (span, length and effective breadth of the wing) should be measured accurately to compute the frequency of wing beat theoretically. Hence mass of the flier was determined by using analytical balance of least count 0.02 mg, whereas wing dimensions were determined by keeping the detatched wings under the enlarger. The wing stroke was observed under synchronised stroboscopic flash (ADEEL AHMAD, 1978, 1982) and the stroke angle $\varnothing$ is about 60°. Insect was allowed to fly in a glass chamber and when it was hovering, flight-sound was recorded on taperecorder (Akai 1720L) using condenser microphone (Sony ECM—19 B). The recorded signals were fed to an oscilloscope (Philips P M—3230) and oscillograms were photographed (Fig. 1) for determining the freo quency of wing beat. Fourier analysis was made by taking Y and corresponding X co-ordinates from the oscilograms (PURANIK & ADEEL AHMAD, 1976). Wing beat frequency was computed by using equations 1 2 and 3 and was tabulated along with the experimental values (Table 1).

RESULTS AND DISCUSSION

Table 1 gives the data on basic aerodynamic parameters-body mass, wing length wing span, effective breadth of the wing and wing swept area and compares the theoretical values of frequency of wing beat with that of the experimental. It can be observed from the table that the body parameters of insects vary widely unlike other large size fliers. The variation in these parameters especially in observed frequency ν_0 values are notable. The frequency values as observed range from 400-600 Hz. The highest wing beat frequency reported in the literature is about 1000 Hz. for *Forcipomyia sp.* (SOTAVALTA 1953). *A. stephensi* has high wing beat frequency of myogenic (asynchronous) nature contrast to neurogenic (synchronous) rhythms as found in many primitive insect orders. This high frequency in myogenic insects has been attributed to 'mechanical resonance of wing-thorax system (PRINGLE, 1976); however, it has been observed in the present investigation that this high frequency is associated with low wing stroke angle and this may be a general feature.

TABLE 1. Comparison of frequency of wing vibration of *A. stephensi* along with the insect body parameters.

Sex	M_f $\times 10^{-3}$ gm	l cm	L cm	B_{eff} cm	S_w cm^2	e g/cc	ν_h Hz	ν_c Hz	ν_m Hz	ν_o Hz	ν_h/ν_o	ν_c/ν_o	ν_m/ν_o
Male	1.0	0.28	0.66	0.057	0.082	0.0011	1083	103	389	390	2.77	0.26	0.99
	1.6	0.27	0.67	0.076	0.076	0.0011	1129	140	503	500	2.25	0.28	1.00
	1.8	0.28	0.65	0.068	0.082	0.0011	1083	138	587	600	1.80	0.23	0.97
	1.8	0.28	0.71	0.075	0.082	0.0011	1083	138	532	520	2.08	0.26	1.02
	2.0	0.30	0.72	0.067	0.094	0.0011	1000	127	577	520	1.92	0.24	1.10
	2.0	0.31	0.74	0.071	0.100	0.0011	963	119	512	500	1.92	0.24	1.02
	2.1	0.29	0.69	0.690	0.088	0.0011	1040	139	629	600	1.73	0.23	1.04
	2.1	0.29	0.70	0.072	0.088	0.0011	1040	139	602	550	1.89	0.28	1.09
	2.2	0.31	0.74	0.071	0.100	0.0011	963	125	563	540	1.78	0.23	1.04
Female	2.9	0.39	0.86	0.077	0.159	0.0011	740	90	431	415	1.78	0.22	1.03
	2.9	0.39	0.86	0.067	0.159	0.0011	740	90	495	470	1.57	0.19	1.05
	2.9	0.42	0.94	0.064	0.185	0.0011	679	78	438	450	1.51	0.17	0.97
	3.0	0.42	0.93	0.064	0.185	0.0011	679	79	460	500	1.36	0.16	0.92
	3.0	0.40	0.90	0.065	0.168	0.0011	718	87	499	475	1.51	0.18	1.05
	3.0	0.40	0.90	0.070	0.168	0.0011	718	87	463	500	1.44	0.17	0.92
	3.0	0.40	0.90	0.068	0.168	0.0011	718	87	477	500	1.44	0.17	0.95
	3.2	0.40	0.96	0.079	0.185	0.0011	679	81	398	400	1.70	0.20	0.99
	3.2	0.41	0.92	0.068	0.176	0.0011	698	86	486	500	1.39	0.17	0.97

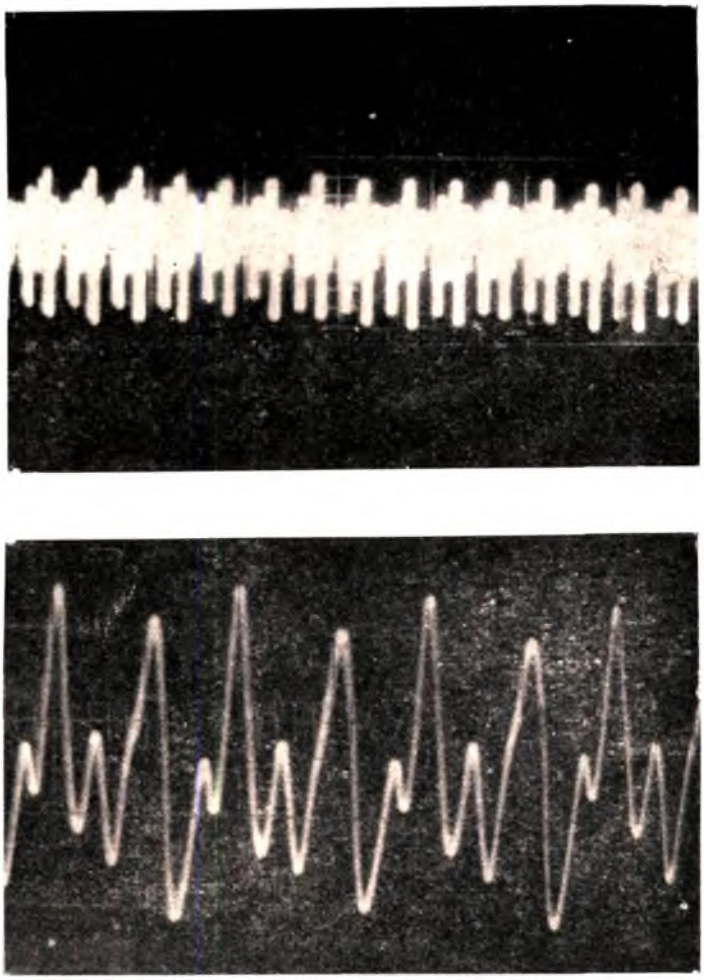

Fig. 1. Typical oscillogram of flight-sound of *A. stephensi*
A: (above) at time mark: 1 div = 5 ms. B: (below) at time mark: 1 div = 1 ms.

Study of the table further shows a remarkable deviation in the case of harmonic oscillator theory and Grawford's relation with the experimental results for the wing beat frequency. Whereas the frequency values by mass flow theory are in good agreement with the experimental values since v_m/v_o values are very close to unity. This reveals that even for high frequency and for small size fliers, such as mosquitoes, the mass flow theory can be applied with a correction in area of the wing disc (S_d). Frequency of the wing vibration is dependent on the basic aerodynamic parameters body mass, span, length and effective breadth of the wing than the sex of the insect. Hence the frequency of the wing beat is species specific parameter along with the body parameters.

TABLE 2. Fourier coefficients and relative amplitudes of flight-sound of *A. stephensi.*

Harmonics	a_n	b_n	A_n
1	8.00	—6.93	10.60
2	7.00	8.65	11.13
2	—16.00	0.00	16.00

Table 2 gives the data on Fourier coefficients a_n and b_n and relative amplitudes A_n for different harmonics. It is also evident from the table that the flight tone of *A. stephensi* contains three harmonics. The third harmonic is prominent and not the fundamental. Since the flight-sound is the direct acoustic consequence of the wing vibration, the analysis of flight-sound may throw light on wing kinematics; in the past, cinematography was used for the same purpose.

Acknowledgements: The authors are grateful to Principal, Nizam College, Hyderabad for providing laboratory facility.

REFERENCES

ADEEL AHMAD (1978) Studies on bioacoustics and aerodynamics of fliers. Ph. D. Thesis, Osmania University, Hyderabad.

ADEEL AHMAD (1982) Effect of body phenomenon & environmental influences on the flight-sound of *Tesseratoma javanica. Indian J. exp. Biol.*, **20** (9), 682—686.

GRAWFORD, F. S. (1971) Comments on: The physics and physiology of insect flight. *Am. J. Phy.*, **39**, 584.

GREEENEWALT, C. H. (1960) The wings of insects and birds as mechanical oscillators. *Proc. Am. Phil. Soc.*, **104**, 605—611.

KAHN, M. C. & W. OFFEN-HAUSER, JR. (1949) The first field tests of recorded mosquito sounds used for mosquito destruction. *Am. J. Trop. Med.*, **29**, 827—836.

PRINGLE, J. W. S. (1976) The muscles and sense organs involved in insect flight, 3-15, *in: Insect flight* (ed. RAINEY R. C.), Blackwell Scientific Publication, Oxford & London.

PURANIK, P. G. & ADEEL AHMAD (1976) Fourier analysis of the flight-sound of the pentatomid bug *Tesseratoma javanica* Thunberg & the pressure pattern of its wings. *Ind. J. exp. Biol.*, **14**, 279—281.

PURANIK, P. G., G. GOPALAKRISHNAN, ADEEL AHMAD & N. CHARI (1977) Wing beat frequency of a flier-mass flow theory. *Proc. Indian Acad. Sci.*, **85 B**, 327—339.

SOTAVALTA, O. (1952) The essential factors regulating the wing stroke frequency of insects in wing mutilation and loading experiment at sub-atmospheric pressure. *Ann. Zool. Soc, Vanamo.*, **15** (3), 1—67.

SOTAVALTA, O. (1953) Recordings of high wing stroke and thoracic vibration frequency in some midges. *Biol. Bull.*, **104**, 439—444.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 53 *to* 60

EFFECT OF THERMOSTABLE EXOTOXIN OF *BACILLUS THURINGIENSIS* BERLINER ON *ACHAEA JANATA* L.

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The thermostable crude β- exotoxin of *Bacillus thuringiensis* variety *thuringiensis* has no effect on eggs of *A. janata*. Oral feeding of exotoxin to third and fourth instar larvae led to larval mortality, reduction in pupal weight and deformity. Feeding of graded doses of exotoxin to 5th instar larvae resulted in delay in developmental period, reduction in pupul weight, and pupal deformity. Deformities in mouthparts and antennae of the adult were also observed. Larval feeding, at the rate of 100μl/larva, of exotoxin resulted in the malformations of various body appendages like mouthparts, antennae and legs of the moth. Longevity, fecundity and size of the oocytes were also reduced in the exotoxin fed insects.

(Key words: exotoxin, *Bacillus thuringiensis, Achaea janata*)

INTRODUCTION

β—exotoxin is a heat stable toxin secreted out into the medium during vegetative growth phase by strains of *Bacillus thuringiensis* serotypes 1, 4a—4c, 5, 7, 9 and 10. It is considered to be a structural analogue of AMP containing adenine, ribose, D-glucose and allaric acid with a phosphate group having a molecular weight of 700 (FARKAS *et al.*, 1969). The exotoxin is highly toxic to several orders of insects (BURGERJON & MARTOURET, 1969), spider mites (KRIEG, 1968), plant pathogenic nematodes (PRASAD *et al.*, 1972) and animals (BARKAR & ANDERSON, 1975; LAURENT, 1968). It produces acute and chronic toxicities. IGNOFFO & GREGORY (1972) and BURGES (1975) demonstrated the teratological effects of exotoxin in the lepidopterous insects. The teratological effects produced on *Achaea janata* following the treatment of crude β—exotoxin of *B. thuringiensis* var. *thuringiensis* (Serotype 1) are reported in this paper.

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MATERIALS AND METHODS

The culture of *A. janata* was maintained on castor leaves at 28$\pm$1°C throughout the experimental period.

Preparation of exotoxin: Pure culture of *B. thuringiensis* var. *thuringiensis* obtained from Pasteur Institute, Paris, was subcultured on nutrient slant and subsequently was grown on nutrient broth medium. The culture was incubated at 30°C for 5 days. The biomass containing vegetative cells, spores and crystals was separated from the medium by centrifuging it at 12000 g. The supernatant containing the β-exotoxin was autoclaved at 120°C for 15 min to kill any traces of spores and crystal fragments. The autoclaved material was further concentrated 20 times by evaporating it in an incubator at 60 $\pm$ 1°C.

Eggs were treated by dipping in the concentrated solution of exotoxin for 5 min. Third

4th and 5th instar larvae were fed on leaf disc of castor leaves treated with exotoxin at the rate of 100 μl/disc and subsequently reared on clean food. Fifth instar larvae were fed with doses ranging from 10 to 200 μl. Teratological observations on pupa and appendages of head and thorax of adults were recorded. Measurements were made from the permanent slides of the appendages. Another batch of 5th instar larvae was fed with exotoxin at the rate of 100 μl/disc and the emerging moths were sexed and their longevity and fecundity were recorded. Ovaries and testes of at least 20 moths each from treated and control group were dissected and their size was recorded.

RESULTS AND DISCUSSION

Effect of exotoxin on various stages/instars: The effects of exotoxin on various stages of *A. janata* are presented in Table 1. The exotoxin did not affect the hatching of eggs and the hard impermeable chorion of the egg shell would have served as barrier against the penetration of exotoxin. Similar results were reported with the treatment of exotoxin on the eggs of *Trichoplusia ni* (IGNOFFO & GREGORY, 1972).

The 3rd instar larvae when fed with exotoxin resulted in lighter pupae. However, no deformity was noticed either in pupal or adult stage. The exotoxin treatment to the 4th instar larvae on the first day resulted in death of the larvae before or at moulting due to the difficulty in shedding the exuviae. However, when the larvae were fed with exotoxin on the second day, the larvae moulted to 5th instar, but some of the larvae pupated partially and also malformed (Fig. 1). Death at the time of moulting as well as loss in weight of pupae were reported due to exotoxin in bollworms

TABLE 1. Effect of exotoxin on various stages/instars of *A. janata*.

Stage/instar of *Achaea janata*	Pupal weight (gm)	Deformities observed
Eggs treated by dipping in exotoxin (5 min)	—	No effect.
Third instar*	0.776±0.05	No pupal or adult deformity observed.
Fourth instar*		
(a) First day	—	All larvae died before moulting; delay in moulting.
(b) Second day	0.74±0.092	All larvae moulted from 4th to 5th instar. Only 40 per cent of the 5th instar pupated having some abnormality.
Fifth instar*	0.76±0.055	Buds of antennae and mouthparts were deformed in pupal stage. Atrophy of mouthparts and antennal deformity were noticed in adults.
Control	0.84±0.035**	No deformity either in pupal or adult stage.

* These stages were provided with exotoxin at the rate of 100 μl/disc/larva.
** Significant at 1% level.

Fig. 1. Exotoxin fed larvae of *A. janata* showing various degrees of malformations. A-larva died at moult; B—exuviae attached to the larva; C, D, E—Partial and malformed pupae. F—Adult with atrophied mouth parts.

Fig. 2. Malformed pupae devoid of cuticle in the bud region of mouth parts and antennae.
N—Norma'; T—Treated.

TABLE 2. Effects of different doses of exotoxin on the 5th instar larvae of *A. janata*.

Concentration of exotoxin (μl)	Percentage area fed	Average fifth instar developmental period (days)	Average pupal weight (g)	Pupation (%)	Pupae deformed (%)	Intensity of pupal deformity	Moth emergence (%)	Deformities observed in moths			
								Mouth parts	Antennae	Leg	Wings
200	100	7.80±0.83	0.533±0.034	60	100	+++	33.3	Atrophied (100%)	Atrophied (100%)	Tarsal deformity on fore leg (100%)	Deformed
100	100	7.60±0.547	0.526±0.079	90	100	++	88.3	Atrophied (100%)	Affected (75%)	—	—
50	100	7.33±0.547	0.528±0.070	100	100	+	100.0	Affected	—	—	—
25	100	7.25±0.707	0.556±0.070	100	80	±	100.0	—	—	—	—
10	100	7.37±0.744	0.553±0.065	100	20	—	100.0	—	—	—	—
Control	100	5.30±0.675**	0.649±0.055**	100	Nil	Nil	100.0	—	—	—	—

(+++) = Severely affected Proboscis + antennae + leg.
(+) = Less affected only proboscis).
(—) = No effect.
(++) = Affected (proboscis + antennae).
(±) = Very little effect.
(**) = Significant at 1% level.

(IGNOFFO & GREGORY, 1972). Larval mortality and partial pupation of the surviving larvae were also reported in *Musca domestica* (CANTWELL *et al.*, 1964) and *Tipula paludosa* (LAM & WEBSTER, 1972) with the treatment of exotoxin.

The feeding of exotoxin to 5th instar resulted in significant reduction in pupal weight, and deformities in pupal and adult stages.

Effect of different doses of exotoxin on 5th instar: Differential response was observed with the graded doses of exotoxin fed through leaf disc (Table 2) Very little mortality was observed and malformations were seen in pupae and adults.

The buds of mouthparts and antennae clearly visible in the pupae were severely affected at high doses of 100 and 200 μl of exotoxin (Fig. 2). In lower concentrations, there was a small unmelanised spot at the posterior portion of the head on the axis of the proboscis bud.

The percentage of moth emergence was lowered at higher concentrations, however, moth emergence remained unaffected at lower concentrations of exotoxin. Complete atrophy of mouth parts was noticed in most of the moths. Irregular and unequal deformity of mouth parts were noticed at lower doses of exotoxin. There was complete absence of antennae at higher doses, whereas at lower doses various degrees of malformations were observed. Deformity in the legs and wings was noticed at higher doses.

The growth of an established cell line of *Heliothis zea* was significantly retarded after treatment of exotoxin and this was attributed to the inhibition of RNA synthesis (KIM *et al.*, 1972). Further, the injection of exotoxin into larvae of *T. ni* inhibited protein and nucleic acid synthesis (KIM *et al.*, 1972). It can be inferred from these findings that the delay in development and the malformations in various appendages in *A. janata* are the reflection of these changes that have taken place due to the feeding of exotoxin.

Effect of exotoxin on longevity and fecundity: The data obtained on longevity and facundity of the moths, which were earlier, during 5th instar, fed with 100 μl of the exotoxin are presented in Table 3.

The surviving capacity of the adult was reduced from 10.36 to 6.08 days due to exotoxin treatment. The fecundity was zero compared to that of control which laid on an average per female 78.33 eggs. The reduction in longevity and fecundity was undoubtedly due to the inability of the adults to feed on honey solution due to the atrophy of the proboscis. Besides, dissection of exotoxin fed moths revealed that there was retarded development of testes and oocytes. Unidimensional measurements of testis and oocytes from treated insects indicated that the size of the testis was little affected but the size of the oocytes was significantly reduced as compared to healthy insects.

Reduction in longevity of adults due to exotoxin was also reported in cabbage looper, bollworms (IGNOFFO & GREGORY, 1972), *Prodenia eridania* (DAVID & VAGO, 1963) and *Drosophila melanogaster* (PROKOPEV *et al.*, 1976). Complete loss of fertility in different fleas (YAKUMIN, 1977; BURGERJON & BAICHE, 1967) and reduction in fecundity in *Drosophila* (PROKOPEV *et al.*, 1976) cabbage looper and bollworms (BURGES, 1975) were also observed in treatment with exotoxin.

Differential effect of exotoxin between male and female moth as observed in the present studies was reported by HITCHINGS (1967).

TABLE 3. Effect of exotoxin on longevity and fecundity of *A. janata*.

Particulars	Untreated (control) insects	Exotoxin treated insects
Longevity of adult moth (days	10.36 ±1.43**	6.08 ±0.515
Number of eggs laid per female	78.33	Nil
Measurement of testis (mm)		
Length	2.320±0.15	2.450±0.5
Breadth	1.980±0 225*	1.800±0.435
Measurement of oocytes (mm)		
Length	0.333±0.033**	0.228±0.062
Breadth	0.267±0.035**	0.200±0.05

* Significant at 5% level. ** Significant at 1% level.

TABLE 4. Effect of exotoxin on the appendages of head capsule of *A. janata*.

Appendage	Untreated insect (mm) (control)	Exotoxin treated (insect mm)	Remarks
Head capsule			
a) Length	3.50±0.18	3.60±0.12	NS
b) Breadth	2.20±0.27	2.25±0.00	NS
Mouthparts			
a) Length of proboscis	12.20±0.53**	0.0	80%
		1.0 to 4.0	20%
b) Length of labial palp	3.50±0.03**	0.0	80%
		0.0 to 1.0	20%
Antennae			
a) Length	13.72±0.63**	3.33±2.96	
		0–2 mm	40%
		3–5 mm	30%
		6–9 mm	20%
		9 and above	10%
b) Segments (Number)	88.78±4.78**	19.00±16.20	

**Significant at 1% level. NS not significant.

TABLE 5. Effect of extoxin on thoracic appendages of *A. janata*.

Thoracic appendage	Coxae	Trochanter + Femur	Tibium	Tarsus	Total length
Foreleg					
Exotoxin treatment	1.94±0.22	3.29±0.18	2.41±0.27	3.44±0.45	11.42±0.52
Control	2.56±0.12**	3.68±0.31**	2.59±0.32	3.86±0.34*	12.93±0.66**
Midleg					
Exotoxin treatment	Coxae of the legs were fused	5.75±0.40	5.39±0.60	5.34±0.36	—
Control	2.91±0.19**	6.53±0.44**	6.31±0.41**	6.51±0.26**	22.23±0.91
Hindleg					
Exotoxin treatment	1.75±0.27 (Mostly coxae of the legs were fused)	3.78±0.66	4.36±0.76	4.95±0.52	—
Control	2.66±0.23**	4.69±0.27**	5.52±0.25**	6.17±0.42**	19.00±0.83

* Significant at 5% level. ** Significant at 1% level.

Effect of exotoxin on the appendages of the head capsule: In the normal moth of *A. janata* major parts involved in feeding process are the two maxillae which are highly modified to form suctorial proboscis. The latter is composed of two greatly elongated galeae each being channelled in its inner face and the two are held together by means of hooks and interlocking spines. Labium is reduced but a pair of 3—segmented labial palpi are present.

In the exotoxin fed moths (Table 4) the deformities ranged from varied length of proboscis, formation of small swellings/bulbs at the distal end of proboscis and complete atrophy of proboscis. Similarly various degrees of deformities were observed in labial palpi.

The reduction in the length of the two galeae, especially when they were differing in length, must be affecting the interlocking arrangement and thereby affecting the formation of food channel.

Prevention of mouth parts development on account of exotoxin was demonstrated in *H. zea*, *H. virescens*, *T. ni*, *S. exigua*, *Estigmene acrea* and *Pectinophora gossypiella* (IGNOFFO & GREGORY, 1972) and *Galleria mellonella* (BURGES, 1975).

The antennae of healthy moth were setaceous and looked like a whip with a length of 13.72 mm and with about 80 to 90 segments. In the exotoxin fed moths, the length of the antennae as well as the number of antennal segments were reduced. Abnormal club like structures were also noticed at the tip of the antennae. Similar antennal deformities were also reported in *Leptinotarsa decemlineata* (BURGERJON *et al.*, 1969).

Effect of exotoxin on the thoraric appendages: In general there was a significant reduction in the length of the legs of treated insects compared to control (Table 5). The trend of effect of exotoxin on the various parts of legs indicated

that firstly the coxae are effected followed by the reduction in the length of tarsal segments. Other parts like trochanter, femur, tibia were comparatively less affected. The wings of *A. janata* are not deformed at the concentration tested in this experiment. The observed effects of exotoxin on the reduction of length of the above appendages in *A. janata* are also reported for the first time.

The effect of exotoxin is cumulative and ingestion of it at larval stage affected the appendages of head and thorax and the reproductive function of moths of *A. janata*.

REFERENCES

BARKER, R. J. & N. F. ANDERSON (1975) Evaluation of β—exotoxin of *Bacillus thuringiensis* Berliner for the control of flies in chicken manure. *J. Med. Ent.*, **12** (1), 103—119.

BURGERJON, A. & D. MARTOURET (1971) Determination and significance of the host spectrum of *Bacillus thuringiensis*, 305—321, *in: Microbial Control of Insects and Mites* (eds. H. D. BURGES and N. W. HUSSEY). Academic Press, London—New York, 861 pp.

BURGERJON, A., G. BAICHE & P. H. CALS (1 69) Teratology of the Colorado potato beetle, *Leptinotarsa decemlineata* as provoked by larval administration of the thermostable tox n of *Bacillus thuringiensis*. *J. Invertebr. Pathol.*, **14**, 272—278.

BURGES, H. D. (1975) Teratogenicity of the thermostable exotoxin of *Bacillus thuringiensis* in *Galleria mellonella*. *J. Invertebr. Pathol.*, **20**, 419—420.

CANTWELL, G. E., A. M. HEIMPEL & M. J. THOMPSON (1964) The production of an exotoxin by various crystal forming bacteria related to *Bacillus thuringiensis* var. *thuringiensis* Berliner. *J. Insect Pathol.*, **6**, 466—480.

DAVID, J. & C. VAGO (1967) Influence des toxins de *Bacillus thuringiensis* sur divers caracteres physiologiques de *Drosophila* adults. *Entomophaga*, **12**, 153—159.

FARKAS, J., S. K. SEBESTA, K. HORSKA, Z. SAMEK, L. DOLEJS & F. SORM (1969) The structure of exotoxin of *Bacillus thuringiensis* var. *gelechiae*. *Collect. Czech. Chem. Commun.*, **34**, 1118—112.

IGNOFFO, C. M. & B. GREGORY (1972) Effects of *Bacillus thuringiensis* β—exotoxin on larval maturation, adult longevity, fecundity and egg viability in several species of Lepidoptera. *Env. Ent.*, **1**, 269—272.

HITCHINGS, D. L. (1967) *Bacillus thuringiensis* a reproduction inhibitor for southern army worm. *J. econ. Ent.*, **60**, 596—597.

KIM, Y. T., B. G. GREGORY, C. M. IGNOFFO & M. SHAPIRO (1972 a) The β—exotoxin of *Bacillus thuringiensis*. IV. Effects on *in vitro* Synthesis of macromolecules in an insect cell line. *J. Invertebr. Pathol.*, **20**, 284—287.

KIM, Y. T., B. G. GREGORY & C. M. IGNOFFO (1972) The β—exotoxin of *Bacillus thuringiensis*. III. Effect on *in vivo* synthesis of macromolecules in an insect system. *J. Invertebr. Pathol.*, **20**, 46—50.

KRIEG, A. (1968) Effectiveness of *Bacillus thuringiensis* exotoxin on *Tetranychus telarius* (Acarina: Tetranychidae). *J. Invertebr. Pathol.*, **12**, 478.

PRASAD, S. S. S. V., K. V. B. R. TILAK & K. G GOLLAKOTA (1972) Role of *Bacillus thuringiensis* var. *thuringiensis* on the larval survivability and egg hatching of *Meloidogyne* spp. the causative agent for root knot disease. *J. Invertebr. Pathol.*, **20**, 377—378.

LAM, A. B. Q. & J. M. WEBSTER (1972) Effect of DD—136 nematode and of a β—exotoxin preparation of *Bacillus thuringiensis* var. *thuringiensis* on leather jackets, *Tipula paludosa* larvae. *J. Invertebr. Pathol.*, **20**, 141—149.

LAURENT. P. (1978) Action of thermostable *bacillus thuringiensis* exotoxin of different strains of cells in culture. *Rev. Can. Biol.*, **37** (2), 127—130.

PROKOPEV. V. N., B. M. YAKUMIN, V. D. CHERVYAKOV & A. M. DUBITSKII (1976) Pathological changes in fleas caused by the exotoxin of *Bacillus thuringiensis*. *Parazitologiya*, **10** (3), 222—226.

YAKUMIN, B. M. (1977) The influence of thermostable exotoxin on the fertility of fleas of daughter generation. *Med. parazitol. parazit. Bolezni*, **46** (4), 491—493.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 61 *to* 65

SEQUENTIAL SAMPLING PLAN FOR CABBAGE LEAF WEBBER, *CROCIDOLOMIA BINOTALIS* (ZELL)

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(Received 12 June 1982)

A sequential sampling plan has been developed during the study to evaluate the need for chemical control of cabbage leaf webber, *Crocidolomia binotalis*.

(Key words: sequential sampling plan, chemical control, cabbage leaf webber, *Crocidolomia binotalis)*

INTRODUCTION

A sequential plan which is characterized by its flexible sample size was originally developed for quality approval of manufactured goods. It is a sampling procedure where the samples are taken in sequence and decision depends on every unit included in the sample. It is advantageous because it allows rapid classification of population levels with minimum number of samples chosen following an appropriate sampling procedure. In case of insect sampling the population density fluctuates with time and fixed sampling procedure cannot provide an accurate estimate of the population. Sequential sampling has been developed for several economically important insect species including spruce budworms, *Choristoneura fumiferana* (Clemens) (MORRIS, 1954; WATERS, 1955), imported cabbageworm *Pieris rapae* (L) (HARCOURT, 1966 a), white grubs (IVES & WARREN, 1965), cabbage looper *Trichoplusia ni* (Hubner) on cauliflower (HARCOURT, 1966 b) and corn earworm, *Heliothis zea* (Boddie) (WOLFENBARGER & DARRACH, 1965). A sequential sampling procedure needs very small number of samples when the population is low or high. With population density close to threshold value more samples are required for classification of population. Thus sequential sampling plan allows rapid yet accurate decision to be made pertaining to treatments and also allows determination of the degree of control against the pest by specific treatment. For the present study sequential sampling plan has been developed to evaluate the need for chemical control of cabbage leaf webber, *Crocidolomia binotalis* (Zell.).

MATERIAL AND METHODS

Before a sequential sampling plan can be developed, the mathematical distribution of pest population under field condition must be known. SUMAN *et al.* (1980) determined the spatial pattern of cabbage leaf webber as being of aggregative nature and adequately expressed by the negative binomial distribution. The common k used in the present calculations is based on sampling data.

Two statistical hypotheses H_0 and H_1 were used to differentiate between levels that do and do not require treatment respectively. The two types of errors used are: α = the probability of recommending an unnecessary treatment (i.e., accepting H_1 when H_0 is the true conditions) and β = the probability of failing to recommend a needed treatment (i. e., accepting H_0 when H_1 is true condition). For sampling of cabbage leaf webber population, α and β were set a 0.01.

Contribution No. 62/82 of the Indian Institute of Horticultural Research.

This means that the risk of committing either type of error is one in ten. The decision lines are taken from OAKLAND (1950) and MORRIS (1954) and pertain to negative binomial distribution. These lines are written in the form of equation as:

$$d = bn + h_0 \text{ (lower line)}$$

$$d = bn + h_1 \text{ (upper line)}$$

where d is commulative number of larvae, n is number of plants sampled and b is the slope of the line. The slope and intercept are calculated as follows:

$$b = k \frac{\log \frac{q_1}{q_0}}{\frac{p_1 \, q_0}{p_0 \, q_1}}$$

$$h_0 = \frac{\operatorname{Log} B}{\log \frac{p_1 \, q_0}{p_0 \, q_1}} \quad \text{where } B = \frac{\alpha}{1-\beta}$$

$$h_1 = \frac{\log A}{\log \frac{p_1 \, q_0}{q_1 \, p_0}} \quad \text{where } A = \frac{1-\alpha}{\beta}$$

The following three infestation classes were used for present investigation: Light infestation = 0.1 or less larvae/plant; Moderate infestation = between 0.3 and 0.5 larvae/plant; Severe infestation = 1 or more larvae/plant. The population between 0.1 — 0.3 and 0.5 — 1.0 larvae corresponds to indecisive zone for comparing light vs moderate and moderate vs high infestation respectively.

The operative characteristic curve (oc) which is a function of H_0 was calculated as explained by OAKLAND (1950), using two equations related by dumy variable h. Let L (p) be the probability of accepting H_0 and m is population mean per plant, then

$$L(p) \quad \frac{A^h - 1}{A^h - B^h} \; ; \; h_0 \neq 0$$

where A and B are defined earlier.

$$m = kp = k \frac{\frac{1-(q_1)^h}{(q_0)}}{\frac{(p_1 \, q_0)^h}{p_0 \, q_1}} \; ; \; h_0 \neq 0$$

and average sample number was worked from the formula

$$E(n) = \frac{h_1 + (h_0 - h_1) \, L(P)}{kp - b}$$

Although these curves are not essential in the application of sequential sampling plan, they are helpful in visualizing its performance.

RESULTS AND DISCUSSION

The decision lines for light versus moderate infestation (0.1 vs 0.3).

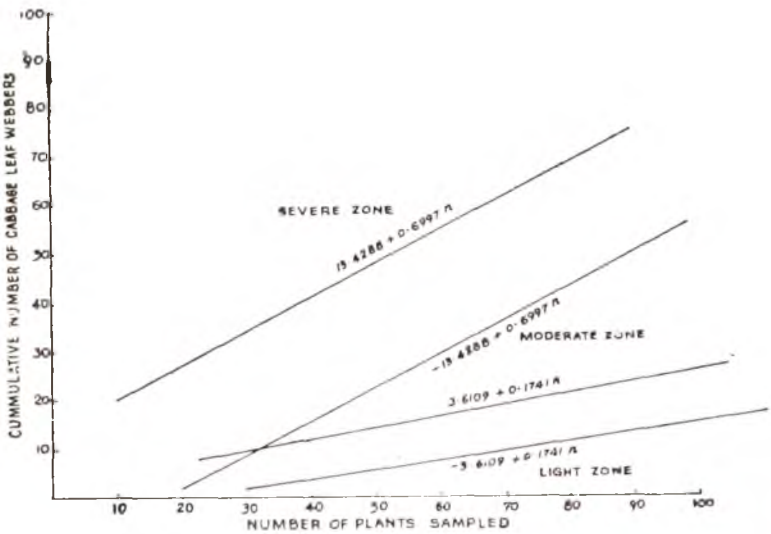

Fig. 1. Seqential sampling graph for $\alpha = \beta$ 0.10.

TABLE 1. Sequential sampling table for treatment decision on cabbage leaf webber, *Crocidolomia binotalis* (Zell).

No. of plants	light vs moderate infestation $\alpha = \beta = 0.10$		moderate vs severe infestation $\alpha = \beta = 0.10$	
10	0	5	0	20
20	0	7	1	27
30	2	9	8	34
40	3	11	15	41
50	5	12	22	48
60	7	14	29	55
70	9	16	36	62
80	10	18	43	69
90	12	19	50	76
100	14	21	57	83

$$d = -3.6109 + 0.1741\ n$$
$$d = 3.6109 + 0.1741\ n$$

and moderate versus severe infestation (0.5 vs 10)

$$d = -13.4288 + 0.6997\ n$$
$$d = 13.4288 + 0.6997\ n$$

are plotted in Fig 1. These lines distinguished regions as light infestation, moderate infestation and severe infestation for making treatment decision. The numerical value of variable d for various values of n, called sequential sampling table are shown in Table 1. Under field condition it is easier to use a sequential sampling table based on sequential sampling graph than to use the graph itself. For using this table a sample of 10 plants should be selected randomly for counts of larval population. The running totals of larval population are to be checked against the table after every sample has been selected. Sampling is to be continued so long as the total remains within light versus moderate or moderate versus severe bands till a decision is achieved.

The operating characteristic curves for light versus moderate and moderate versus severe are shown in Fig. 2. When the mean population per plant is 0.08 larvae per plant, the probablity of labeling infestation light is 0.9. Therefore risk of labeling light infestation as moderate is 0.1. As the population density increases above 0.08 larvae per plant the probability of accepting H_0 decreases. When the population mean is 0.3 larva per plant the probability of labeling light infestation is 0.1. Therefore probability of accepting moderate infestation is 0.9. As the mean population decreases below 0.3 larvae or increase above 0.08 larvae per plant the probability of reaching correct decision is less. Finally when the density level reached 0.175 larva per plant the chances of labeling the infestation light or moderate are equal. The curve for moderate versus severe can also be explained similarly.

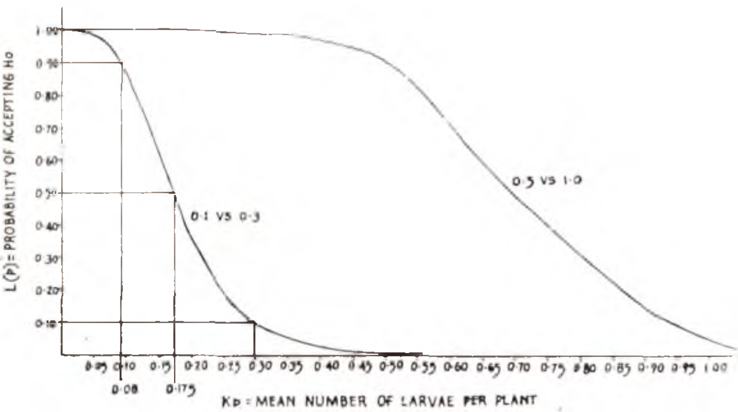

Fig. 2. Operating characteristic curve for $\alpha = \beta = 0.10$.

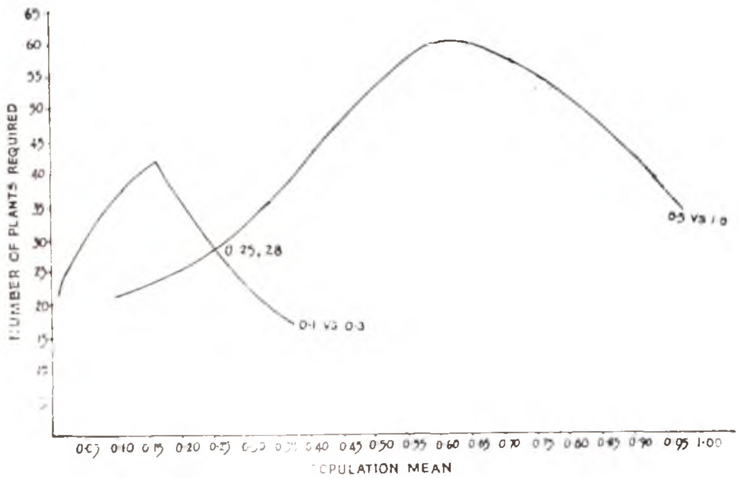

Fig. 3. Average sample number curve for $\alpha = \beta = 0.10$.

The average sample number curve for $\alpha = \beta = 0.10$ for light versus moderate and moderate versus severe infestation are shown in Fig. 3. The average sample number function can be used to predict the average sample number of plants which must be samples under different sequential plans and is useful in comparing the efficiency of different planss. As the population reached 0.16 larvae per plant, 43 plants must be sampled for reaching a correct decision for light versus moderate infestation. With increase or decrease of population above this level, comparatively few plants may be sufficient for reaching a correct decision. Similarly moderate versus severe curve can be explained. These two curves intersect each other for population

density 0.25 larvae per plant and 28 plants shall be sufficient for making treatment decision for the categories of infestation.

REFERENCES

HARCOURT, D. G. (1966 a) Sequential sampling plan for the imported cabbageworm *Pieris rapae* (L.). *Can. Ent.*, **98**, 741—746.

HARCOURT, D. G. (1966 b) Sequential sampling plan for use in control of cabbage looperon cauliflower. *J. econ. Ent.*, **59**, 1190.

IVES, W. G. H. & G. L. WARREN (1965) Sequential sampling plan for white grubs. *Can. Ent.*, **97**, 596—609.

MORRIS, R. F. (1954) A sequential sampling technique for spruce budworm egg surveys. *Can. J. Zool.*, **32**, 302—313.

OAKLAND, G. B. (1950) An application of sequential analysis to white fish sampling. *Biometrics*, **6**, 59—67.

SUMAN, C. L., S. D. WAHI & V. G. PRASAD (1980) Distribution behaviour of cabbage leaf webber (*Crocodolomia binotalis* Zell). on cabbage. *Indian J. agric. Sci.*, **50** (10), 785—787.

WATERS, W. E. (1955) Sequential sampling in forest insects surveys. *Forest Sci.*, **1**, 68—79

WOLFENBARGER, D. A. & J. G. DORROCH (1965) A sequential sampling plan for determining the status corn earworm control in sweet corn. *J. econ. Ent.*, **60**, 277—279.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 67 *to* 69

FIELD EVALUATION OF CERTAIN SYNTHETIC PYRETHROIDS FOR THE CONTROL OF *CYDIA LEUCOSTOMA* MEYR. (OLETHREUTIDAE : LEPIDOPTERA), THE FLUSHWORM OF TEA

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(Received 13 November 1982)

Five synthetic pyrethroids, permethrin, cypermethrin, fenvalerate, deltamethrin[1] and a coded pyrethroid of undisclosed structure, Dowco 417 (vivithrin), were field tested against *Cydia leucostoma* Meyr. *(Laspeyresia leucostoma)*, the flushworm of tea. All the above insecticides were found effective and on par in reducing the population of this pest, while two rounds of spraying with endosulfan did not give satisfactory control.

(Keywords: Cydia leucostoma, cypermethrin, deltamethrin, endosulfan, fenvalerate, flushworm, permethrin, tea, vivithrin).

INTRODUCTION

Serious outbreaks of the flushworm, *Cydia leucostoma* was first noticed during 1955-56 in the tea growing areas of South and N E. India (DAS, 1965) and since then its incidence has been progressively increasing over the years.

A wide variety of insecticides have been recommended for the control of flushworm (MURALEEDHARAN *et al.*, 1982). However, in all cases repeated insecticide application, each following the plucking round, are very essential for satisfactory control. Among the synthetic pyrethroids, permethrin had already been tested against this species and found to be extremely effective (RAO, 1976, 1977). Similarly, MURTHY & CHANDRASEKARAN (1979) evaluated this chemical against leaf roller and flushworm of tea with excellent results. The objective of the present study was to determine the efficacy of a few more synthetic pyrethroids for the control of this leaf-eating caterpillar.

[1] The common name accepted by British Standards Institution for NRDC 161.

MATERIALS AND METHODS

Two field trials were carried out in the tea estates at the Anamallais, Coimbatore District in 1981—82. The fields were in their first year after pruning. The experiments were of randomised block design, each block consisting of sixty tea bushes. There were six treatments (*vide* Table 1), each replicated thrice. Two rounds of spraying were given at an interval of two weeks, with hand operated knapsack sprayers, using a spray volume 500 l/ha. Flushworm present on ten bushes, selected at random from each block, were counted at weekly intervals. Pre-treatment counts were also taken in a similar manner.

RESULTS AND DISCUSSION

The results of the two field trials showed that permethrin, cypermethrin, deltamethrin, fenvalerate and vivithrin were highly toxic to the larvae of *Cydia leucostoma*. BANERJEE (1980) had evaluated permethrin, fenvalerate and deltamethrin

against many other caterpillar pests of tea in N. E. India and found them to be effective at low concentrations. The efficacy of low doses of synthetic pyrethroids had also been established in the case of other pest species of *Cydia*, *C. pomonella* (HAMEED & ALLEN, 1976). The present experiments confirmed that all the formulations of synthetic pyrethroids were effective against flushworm at a low dosage of 200 ml/ha and the higher rate of application of 300 ml/ha was not significantly more effective.

Acknowledgement: We are grateful to Dr. C. S. VENKATA RAM for going through the manuscript and offering valuable suggestions.

REFERENCES

BANERJEE, B. (1980) Synthetic pyrethroids—a new group of insecticides. *Two and a Bud*, **27** (2), 57–60.

DAS, G. M. (1965) Pests of tea in North East India and their control. *Tocklai exptl Stn Mem.*, **27**, 115 pp.

TABLE 1. Evaluation of synthetic pyrethroids against flushworm of tea.

Treatments (Dosage of formulations/ha)	Pretreatment	Number of flushworms/ten bushes (weeks after spraying)			
		I spray		II spray	
		I week	II week	I week	IV/V week†
Experiment I (1981)					
Permethrin (Permasect 25 EC 200 ml)	160 (22.05)a	23 (8.5)a	51 (12.03)a	10 (5.97)ab	15 (7.13)a
do 300 ml)	163 (22.1)a	20 (7.65)a	31 (9.85)a	10 (6.24)ab	9 (5.79)a
Cypermethrin (Ripcord 10 EC 200 ml)	201 (24.47)a	44 (11.22)a	22 (8.62)a	13 (6.32)ab	2 (3.82)a
do 300 ml)	177 (23.11)a	19 (7.97)a	18 (7.85)a	15 (7.34)ab	8 (5.38)a
Vivithrin (Dowco 417–20 EC 200 ml)	201 (24.35)a	36 (10.36)a	39 (10.7)a	13 (6.89)ab	7 (5.38)a
Deltamethrin (Decis 2.8 EC 200 ml)	247 (26.45)a	16 (6.69)a	36 (10.78)a	5 (4.65)a	8 (5.48)a
do 300 ml)	220 (25.65)a	13 (6.02)a	23 (8.24)a	12 (6.69)ab	7 (5.41)a
Fenvalerate (Sumicidin 20 EC 200 ml)	200 (24.63)a	33 (9.77)a	30 (9.6)a	26 (8.93)b	5 (4.65)a
do 300ml	21[illegible] (25.37)a	66 (14.33)ab	24 (8.84)a	1 (3.41)a	5 (4.65)a
Endosulfan (Endosulfan 35 EC 1 litre)	207 (24.65)a	153 (21.12)bc	195 (24.2)b	172 (22.87)c	154 (21.69)b
Untreated Control	196 (24.43)a	261 (27.8)c	204 (23.97)b	312 (30.74)d	222 (25.83)b

(Contd.)

Experiment II (1982)					
Permasect 25 EC 200 ml	219 (25.18)a	195 (23.95)a	66 (13.68)a	10 (6.18)a	1 (3.41)a
do 300 ml	284 (29.24)a	108 (18.2)a	61 (13.4)a	40 (10.74)a	2 (3.73)a
Ripcord 10 EC 200 ml	278 (28.98)a	100 (17.4)a	88 (16.02)a	17 (7.26)a	1 (3.41)a
do 300 ml	303 (30.28)a	95 (17.12)a	107 (17.71)a	20 (7.87)a	1 (3.41)a
Dowco 417-20 EC 200 ml	288 (29.44)a	97 (17.29)a	80 (15.69)a	19 (7.39)a	1 (3.41)a
Decis 2.8 EC 200 ml	206 (24.91)a	73 (14.69)a	68 (13.64)a	18 (6.94)a	1 (3.41)a
do 300 ml	228 (25.99)a	107 (18.09)a	48 (12)a	11 (6.29)a	2 (3.82)a
Sumicidin 20 EC 200 ml	209 (25.15)a	174 (22.52)a	60 (13.44)a	19 (7.73)a	2 (3.82)a
do 300 ml	226 (26.17)a	103 (17.65)a	120 (18.21)a	111 (15.53)a	6 (5.06)a
Endosulfan 35 EC 1 litre	236 (26.76)a	321 (31.03)a	489 (38.22)b	306 (30.39)b	1123 (57.28)b
Untreated Control	215 (25.46)a	411 (31.65)a	427 (35.79)b	312 (30.24)b	1230 (60.34)b

Figures in parentheses are sum of transformed values $\sqrt{X+1}$. Figures followed by the same letter in a vertical column are not significantly different at 1% level. † Data collected at 2nd & 3rd weeks in the first experiment and 2nd, 3rd and 4th weeks in second experiment (after second round of spraying) have been excluded since populations in treatments did not show significant increase.

HAMEED, S. F. & J. G. ALLEN (1976) Toxicity and persistence of some organophosphorus insecticides and permethrin on apple fruits for the control of the codling moth, *Laspeyresia pomonella*. *J. hortic. Sci.*, **51**, 105—115.

MURALEEDHARAN, N., C. KANDASAMY & C. S. VENKATA RAM (1982) Revised recommendations on the control of insect and mite pests of tea in Southern India. *UPASI Handbook of Tea Culture* Series, **23**, 1—14.

MURTHY, R. L. N. & R. CHANDRASEKARAN (1979) Control of flushworm and leaf roller in Tea Evaluation of certain new insecticides. *Proc. Placrosym*, **11**, 263—271.

RAO, G. N. (1976) Report of the entomology Division. *Annu. Rep. UPASI Sci. Dept.*, **50**, 87—101.

RAO, G. N. (1977) Report of the entomology Division. *Annu. Rep. UPASI Sci. Dept.*, **51**, 74—94.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 71 *to* 74

BIOCHEMICAL STUDIES ON DNA, RNA AND PROTEIN CONTENTS OF THE LABIAL GLANDS DURING POSTEMBRYONIC DEVELOPMENT IN *SPODOPTERA LITURA* (NOCTUIDAE: LEPIDOPTERA)

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(Received 2 February 1983)

Larval labial glands synthesize large amounts of nucleic acids and small quantity of proteins during the initial stages of development, upto first half of 5th instar (growth phase). In the second half of the 5th instar and nonfeeding stages, they produce large quantities of exportable proteins and only small quantities of DNA and RNA (secretory phase). This is followed by degeneration of the gland during the prepupal stage of development (histolytic phase).

(*Keywords.* labial glands, DNA, RNA, Proteins)

INTRODUCTION

Although considerable amount of work has been done on the DNA, RNA and protein content of the labial glands (silk glands) of various insects (TAKEYAMA *et al.*, 1958; HASODA *et al.*, 1963; TASHIRO *et al.*, 1968; MATSUURA *et al.*, 1968; OKABE *et al*, 1975), most of these are related to the final instar of the insects. Information dealing with the pattern of nucleic acids (DNA and RNA) and protein during postembryonic developmental stages is limited (MORIMOTO *et al.*, 1968). The present paper describes the changes in pattern of nucleic acids (DNA and RNA) and protein that occur in the labial glands of *Spodoptera litura* during the postembryonic development.

MATERIALS AND METHODS

Spodoptera litura larvae were reared individually in tubes in the laboratory at 27 ± 1°C temp., 12: 12 LD period and 75% RH, on artificial diet (Nagarkatti and Prakash, 1974). For the present study, following stages of insects have been used: (a) 3rd instar; (b) 4th instar; (c) early 5th instar (V_E); (d) mid 5th instar (V_M); (e) late 5th instar (V_L); (f) nonfeeding stage (NF) and (g) prepupal stage (pp).

The labial glands were dissected from the insect of various stages. 10% homogenates of whole glands were prepared in glass distilled water using Potter Elvahjem homogeniser. Nucleic acids were extracted according to the procedure of SCHMIDT & THANNHAUSER (1945), slightly modified according to MUNRO (1966). Protein was estimated by the method of LOWRY *et al.* (1951), using bovine serum albumin as standard.

RESULTS

Table 1 shows that wet weight of the labial glands increases steadily upto non-feeding stage and decreases thereafter. Changes in the DNA, RNA and protein content of the glands are setforth in Table 2.

It can be seen that total DNA content increases continuously from the IIIrd instar to non-feeding stage. It may be noted that it significantly increases upto early Vth instar stage. When the DNA content is expressed as per gram of tissue the

TABLE 1. Weight of a pair of labial glands during various stages of development.

Stage	III	IV	V_E	V_M	V_L	NF	PP
Wet weight	230	1000	1180	2140	3530	4550	3000
in µg	±17	±118	±115	±223	±317	±360	±246

TABLE 2. Changes in the DNA, RNA and protein content of labial glands during various stages of post-embryonic development.

Stage	DNA		RNA		Protein	
	µg/insect	µg gm tissue	µg/insect	µg/gm tissue	µg/insect	µg gm tissue
III	0.46 ±0.07	2014 ±316	2.48 ±0.21	10788 ±906	11.52 ±0.44	50070 ±1896
IV	2.47 ±0.98	2506 ±393	11.86 ±0.11	11200 ±1028	51.33 ±1.67	50769 ±1996
V_E	5.37 ±0.38	4582 ±353	15.61 ±2.22	13091 ±1506	70.76 ±3.07	59966 ±2599
V_M	10.18 ±1.03	4812 ±429	35.08 ±4.17	16363 ±1910	150.68 ±8.41	70410 ±3929
V_L	16.07 ±3.59	4838 ±769	5374 ±5.46	16718 ±2490	278.37 ±20.93	78844 ±5900
NF	20.43 ±1.37	4790 ±740	69.98 ±4.32	16410 ±1752	372.05 ±9.75	81370 ±2082
PP	13.69 ±1.21	4409 ±530	33.11 ±2.42	10972 ±820	203.54 ±11.03	67850 ±3673

Each value represents the mean of at least 5 runs ± S E M.

values increased from IIIrd instar upto early Vth instar but at later stages, the values remained more or less constant upto non-feeding stage with slight decrease during the prepupal stage.

The total RNA content of the gland increases sharply reaching the highest value at non-feeding stage, thereafter a significant decrease was observed during prepupal stage. The concentration of RNA per gram tissue steadily increased upto mid Vth instar stage and remained constant upto non-feeding stage and declined sharplv during the prepupal stage. The RNA/DNA ratio was high during the initial stage, (IIIrd instar), which decreases slowly upto early Vth instar and remained constant upto nonfeeding stage followed by a sharp drop at prepupal stage.

The protein content increases significantly from initial stages of development up to non-feeding stage, but decreases during prepupal stage. Protein, expressed as per gram wet weight, increases from

IIIrd instar to non-feeding stage. It is to be noted that there is a significant increase between the early Vth and mid Vth instar stage. Once again a significant decrease in the protein concentration is noticed at prepupal stage.

DISCUSSION

It is evident from the present work that the large quantities of DNA and RNA are synthesised during the early stages of development of labial glands upto mid 5th instar. There is a constant increase in DNA throughout the developmental stage and this DNA synthesis is also checked by autoradiographic studies using ^{3}H-thymidine as precursor. These studies show labelling of the nuclei upto late 5th instar stage (unpublished observations). This is mainly due to polyploid growth of nuclei without cell division (AKAI & KOBAYASHI, 1965). So the growth of the gland mainly takes place during initial stages upto earlier half of the 5th instar larvae (HASODA *et al.*, 1963; MORIMOTO *et al.*, 1968). But in the later stages of development large quantities of protein is synthesised along with RNA and stored in the gland and is released during the early prepupal stage for the formation of puparia. Hence secretory role is mainly performed by the gland cells during the late stages of development (MORIMOTO *et al.*, 1968). The synthesis of secretory proteins during the secretory phase of metamorphosis is mainly stimulated by 20-hydroxyecdysone, in the salivary glands of *Sarcophaga peregrina* (NAKANO & NATORI, 1978) and *Manduca sexta* (EPSTEIN & LOCKSHIN, 1981). Rapid decrease in the nucleic acid and protein content found during the prepupal stage with the commencement of degeneration or cytolysis of the gland cells, are in agreement with results of other workers (MATSUURA *et al.*, 1968; OKABE *et al.*, 1975; CHENZEI & TOJO, 1972).

It has already been reported by various authors that the salivary glands of Lepidopterous insects start regressing during prepupal stage onwards. This degeneration or the histolysis of the gland is mainly brought about by the autophagosomes and increased activity of hydrolases (MATSUURA *et al.*, 1968; SCHIN & CLEVER, 1965, 1968; LAUFER & SCHIN, 1971; HENRICKSON & CLEVER, 1972), while the activity of certain other enzymes decline in a variety of insect species. So the present study suggests that there are three different phases of gland during the post-embryonic development: (i) growth phase during which gland prepares itself for the secretion; (ii) secretory phase during which large quantity of proteins are synthesised and exported, followed by (iii) histolytic phase during which the gland becomes degenerated.

REFERENCES

AKAI, H. & M. KOBAYASHI (1965) Sites of fibroin formation in the silk gland in *Bombyx mori*. *Nature*, **206**, 529.

CHINZEI, Y. & S. TOJI (1972) Nucleic acid changes in the whole body and several organs of the silkworm, *Bombyx mori*, during metamorphosis. *J. Insect Physiol.*, **18**, **1683—1698.**

EPSTEIN, D. & R. A. LOCKSHIN (1981) Ecdysone stimulated secretion from the salivary glands of *Manduca sexta*. *J. Insect Physiol.*, **27**, 793—798.

HASODA, J., H. SHIGEMATSU, H. TAKESHITA, S. MIZUNO, H. TAKAHASHI & B. MARUO (1963) Ribonucleic acid metabolism is the posterior silk gland of silkworm *Bombyx mori* during the fifth instar. *Biochem. Biophys. Acta.*, **72**, 544—554.

HENRICKSON, P. A. & U. CLEVER (1972) Protease activity and cell death during metamorphosis in the salivary gland of *Chironomus tentans*. *J. Insect Physiol.*, **18**, 1981—2004.

LAUFER, H & K. S. SCHIN (1971) Quantitative studies of hydrolytic enzyme activity in the salivary gland of *Chironomus tentans* during metamorphosis. *Can. Ent.*, **103**, 454—457.

LOWRY, O. H., N. J. ROSEBROUH, A. L. FARR & R. J. RANDALL (1951) Protein measurement with the Folin phenol reagent. *J. biol. Chem.*, **193**, 265—275.

MATSUURA, S., T. MORIMOTO S. NAGATA & Y. TASHIRO (1968) Studies on the posterior silk gland of silkworm *Bombyx mori*. II. Cytolytic processes in the posterior silk gland cells during metamorphosis from larva to pupa. *Cell Biol.*, **38**, 604—614.

MORIMOTO, Y., S. MATSUURA, S. NAGATA & Y. TASHIRO (1968) Studies on the posterior silk gland of silkorm *Bombyx mori*. III. Ultrastructural changes of posterior silk gland ellsin the fourth larval instar. *J. Cell Biol.*, **38**, 604—614.

MUNRO, H. N. (1966) The determination of nucleic acids, 113-176, *in*: *Methods of Biochemical Analysis*. Interscience Publishers, New York.

NAGARKATTI, S. & S. PRAKASH (1974) Rearing *Heliothes armigera* (Hubn) on an artificial diet. *Tech. Bull.*, **17**, 169—173.

NAKANO, T. & S. NATORI (1978) Effect of β— ecdysone on macromolecular synthesis in salivary gland *Sarcophaga peregrina* larvae. *Insect Biochem.*, **8**, 375—381.

OKABE, K., R. KOYANAGI & K. KOGA (1975) RNA in the degenerating silk gland of *Bombyx mori*. *J. Insect Physiol.*, **21**, 1305—1309.

SCHMIDT, G. & S. I. THANNHAUSER (1945) A method for the determination of deoxyribonucleic acid, ribonucleic acid and phosphoproteins in animal tissues. *J. biol. Chem.*, **161**, 83—89.

SCHIN, K. S. & U. CLEVER (1965) Lysosomal and free acid phosphatase in salivary glands of *Chironomus tentans*. *Science*, **150**, 1053—1055.

SCHIN, K. S. & U. CLEVER (1968) Ultrastructural and cytochemical studies of the salivary gland regression in *Chironomus tentans*. *Z. Zellforsch.*, **86**, 262—279.

TAKEYAMA, S., H. ITO & Y. MIURA (1958) Fibroin synthesis and ribonucleic acid metabolism in the silk gland. *Biochem. Biophys. Acta*, **30**, 233—242.

TASHIRO, Y., T. MORIMOTO, S. MATSUURA & S. MAGATA (1968) Studies on the posterior silk gland cells of silkworm, *Bombyx mori*. I. Growth of posterior silk gland cells and biosynthesis of fibroin during the fifth larval instar. *J. Cell Biol.*, **38**, 574—588.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 75 *to* 78

STUDIES ON HOST PREFERENCE OF *APHIS CRACCIVORA* KOCH.

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(Received 12 June 1982)

From amongst the four hosts and their varieties studied, bean was the most preferred host plants for bean aphid *(Aphis craccivora)*. Aphids fed on bean developed faster, lived longer, reproduced more numbers, grew larger and possessed longer antennae. Arhar and groundnut and their important varieties were found unsuitable as hosts and the pest could not survive on these plants beyond second or third instar nymph stage.

(Keywords: host preference, bean aphid)

INTRODUCTION

Aphis craccivora Koch. is a major insect pest of bean and cowpea. Besides, it feeds on several other host plants. They are arhar, gram, lentil and groundnut (WAGHMARE & POKHARKHAR, 1974). Considering the polyphagous nature of the pest much work has been done on its biology, host preference and chemical control (BAKHETIA & SIDHU, 1977; BERNARD, 1969). Though it is an established fact that the type of food plays an important role in the multiplication of pest population, the work on the life cycle of this pest in relation to different host plants is scanty. Keeping in view the above fact, an endeavour has been made to study the biology of *Aphis craccivora* Koch. on lentil as well as on some varieties of groundnut and arhar.

MATERIALS AND METHODS

The bean aphids (*A. craccivora)* used in the experiment were obtained from the laboratory culture reared on local bean sprouts *(Dolichos lab lab)* whereas, the host plants used in the trial were grown in the pots of the Departmental glasshouse (Tables 1 and 2).

Twenty days old seedling of the host plants were cut and kept in petri plates after wrapping them with moist cotton plug. A single first instar nymph was released on each petri plate and the observations were recorded after every 24 hour for their growth and moulting at room temperature 27°±5°C.

Fresh food was provided every day. The developmental period of the aphid was considered as the period between the date of release of the first instar nymph to the date on which it became adult. The longevity of the adult was considered as the period between the date of emergence of the adult to the date of its death. The fecundity was noted as the total number of young ones produced by a single female aphid in its life time.

In case of the hosts where the nymphs could not survive, the longevity and fecundity on these host plants were determined by releasing the 4th instar nymph reared on bean sprouts (Table 2).

Further, the nymphs of each instar and apterous adults were collected from each host plants and were fixed in 70 per cent alcohol, cleared in xylol for the measurement of length and width of the body and antennal length which was made with the help of micrometer under microscope.

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RESULTS AND DISCUSSION

It is evident from Tables 1-3 that there were statistically significant differences in the developmental period, fecundity and longevity of bean aphid reared on four different host plants and their important varieties namely bean, lentil *(JL-1)* arhar *(bahar, V-type, No. 148, basant* and *G-3)* and groundnut *(JM-59, Jawahar-1, Jyoti* and *Sulemath*).

Table 1 reveals that the aphids reared on bean sprouts developed faster (4.3 days) and the adults lived longer (12.4 days) produced more offspring (56.9 nymphs) and were longer in size (1 948 mm^2) and possessed longer antennae (1.281 mm) than on arhar and lentil (Table 3). BERNARDO (1961) and WAGHMERE & POKHARKHAR

TABLE 1. Effect of different host plants on the longevity, developmental period and fecundity of bean aphid *Aphis craccivora* Koch.*

Host plants	Developmental period (days)	Adult longevity (days)	Fecundity
Bean	4.3	12.4	56.9
Arhar : *T—21*	5.5	10.0	23.7
Arhar : *G—3*	5.3	8.9	26.6
Lentil : *JL—I*	5.2	7.9	23.4
Arhar : *V Type*	5.4	7.2	21.7
Arhar : *Bahar*	5.5	7.3	20.6
C D at 5% level	0.53	3.30	8.82

*Average of ten insects.

TABLE 2. Effect of different host plants on the longevity and fecundity of *Aphis craccivora* Koch. released at fourth instar*.

Sl. No.	Treatments (Host plants)	Longevity (in days)	Treatments (Host plants)	Fecundity (No. of nymphs)
1.	Bean	12.40 (3.628)	Bean	56.90 (7.126)
2.	Arhar : *No. 148*	3.10 (1.862)	Arhar : *Basant*	7.10 (2.70)
3.	Arhar : *Basant*	2.80 (1.808)	Arhar : *No. 148*	6.90 (2.555)
4.	Groundnut : *M—59*	2.50 (1.725)	Groundnut : *JM—59*	6.20 (2.175)
5.	Groundnut : *awahar—I*	2.40 (1.678)	Groundnut : *Sulemath*	4.40 (2.063)
6.	Groundnut : *Sulemath*	2.20 (1.576)	Groundnut : *Jawahar*	3.80 (1.810)
7.	Groundnut : *Jyoti*	2.10 (1.543)	Groundnut : *Jyoti*	3.60 (1.809)
	C D at 5% level	0.3070		0.9876

The transformed values are given in paranthesis. Formula for transformation $\sqrt{2+0.5}$
*Average of ten insects.

TABLE 3. Effect of different host plants on body size and antennal length of bean aphid, *Aphis craccivora* Koch.*

Host plants	Size of the body in mm^2 (Length×Width)					Size of the antenna in mm				
	I	II	III	IV	Adult	I	II	III	IV	Adults
Bean	0.226	0.279	0.926	1.218	1.948	0.358	0.385	0.680	0.790	1.281
Arhar: *T–21*	0.234	0.259	0.547	0.805	1.532	0.358	0.394	0.556	0.637	1.090
Arhar: *G—3*	0.157	0.363	0.615	0.864	1.430	0.294	0.435	0.633	0.702	0.969
Lentil: *JL—1*	0.143	0.254	0.551	0.724	0.873	0.338	0.386	0.686	0.783	0.972
Arhar: *Jyoti*	0.167	0.349	0.510	0.782	1.024	0.328	0.416	0.596	0.706	0.994
Arhar: *Bahar*	0.169	0.239	0.524	0.841	1.490	0.322	0.321	0.594	0.706	1.160
C D at 5% level	0.044	0.064	0.105	0.140	0.239	0.046	0.044	0.074	0.070	0.132

*Average of ten insects.

(1974) have also reported bean as the most preferred host plant of *A. craccivora*. Different varieties of arhar and lentil were not significantly different from one another. However, the longevity of adults reared on arhar *T-21* was at par with the other varieties of arhar and lentil on the one hand and with bean on the other.

A perusal of literature reveals that arhar (WAGHMERE & POKHARKHAR, 1974) and groundnut (DORGE *et al.*, 1966; BAKHETIA & SIDHU, 1977) are the most preferred host plant of bean aphid, whereas, in the present investigation, in general, both the host plants were found unsuitable for the bean aphid. The non-preference of groundnut and arhar may be due to difference in varieties tested by these workers.

The present investigation was further extended to compare the relative preference of bean aphid on the different varieties of arhar and groundnut. As the bean aphid could not develop normally on these hosts and their varieties, the comparison was made by releasing the fourth instar nymphs of aphid fed on bean sprouts and then rearing them on these hosts for recording only the longevity and fecundity (Table 2).

Arhar *(No. 148* and *Basant)* was liked more than groundnut *(Jawar 1*, *Sulemath* and *Jyoti)*. The difference between arhar varieties *Bahar* and *No. 148* and also in groundnut varieties *Sulemath*, *Jawhar-1* and *Jyoti* were non-significant. Groundnut *JM-59* was significantly preferred than *Jyoti*. All these varieties of arhar and groundnut were the unpreferred host plants than bean sprouts for bean aphid.

Further, Table 3 reveals the influence of these host plants on the size of the body and antennal length of *Aphis craccivora* Koch. that varied from instar and the adults, but were non-significant. The measurement of body of different instars on all the test host plants seems more valid as it exhibits the over all influence

on the growth of the test insects. In general, the largest size and antennal length of the aphid was recorded on bean. The least favourable host plant was lentil *JL-1* and arhar *G-3* for both the body size and antennal length respectively.

REFERENCES

BAKHETIA, D. R. C. & A. S. SIDHU (1977) Biology and seasonal activity of the groundnut aphid *Aphis craccivora* Koch. *J. Res. Punjab agric. Univ.*, **14** (3), 299—303.

BERNARD, E. N. (1969) Effect of six host plants on the biology of black bean aphid *A. craccivora* Koch. *Phillip. Ent.*, **1**, 287—292.

DORGE, S. K., W. P. DALAYA & O. B. KAUL (1966) Studies on bionomics and control of groundnut aphid (*Aphis craccivora* Koch.). *Labdev. J. Sci. Technol.*, **4** (3), 165—167.

WAGHMARE, S. S. & R. N. POKHARKAR (1974) Host preference studies of *Aphis craccivora* Koch. *Res. J. Mahatma Phule agric. Univ.*, **5** (1), 28—35.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 79 *to* 81

ASHWEEVIL (*MYLLOCERUS SUBFASCIATUS* GUERIN) DAMAGE ON EGGPLANT (*SOLANUM MELONGENA* L.) AND ECONOMICS OF ITS CONTROL

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(*Received 13 November 1982*)

Six Insecticides *viz.*, aldicarb, phorate, carbofuran, quinalphos, aldrin and lindane were tested against grubs of *Myllocerus subfasciatus* Guerin. All the treatments were significantly superior over control in reducing the grub population and wilting and thereby increasing the yield. Aldicarb was the best with maximum net income but the benefit/cost ratio was maximum in the case of phorate. Significant positive correlation was observed between the grub population and wilting while significant negetive correlation was obtained between grub population and plant height and grub population and yield.

(*Keywords: Myllocerus subfasciatus, Solanum melongena.* control economics, insecticidal control)

INTRODUCTION

Ashweevil, *Myllocerus subfasciatus* Guerin has been reported as a pest of eggplant, *Solanum melongena* L. and other solanaceous crops (AYYAR, 1920; SUBRAMANIAM, 1958). KALYANAM (1967) listed it as one of the economically important weevils in India. The larvae are exclusively root feeders resulting in plant stunting and finally wilting while the adults are defoliators. In Karnataka, the species has assumed a major pest status and often complete crop failures have been reported due to heavy larval infestation (SIDDAPPAJI, 1976). Although there exists extensive literature on distribution and host range, a few generally cursory observations have been made on the control of *M. subfasciatus* Guerin grubs. Different insecticides have been evaluated by UTHAMASAMY *et al.* (1973) against adults of the pest. The present studies were, therefore, undertaken to evaluate six insecticides for their relative efficacy and economics in controlling the ashweevil grubs infesting roots. Efforts have also been made to establish correlation between grub population and various plant growth parameters.

Indian Institute of Horticultural Research, Contribution No. 154/82

MATERIALS AND METHODS

A field experiment was conducted in randomised block design with variety *'Pusa Purple Cluster'*. Individual plot size was 4×3m. There were six insecticidal treatments (Table 1) besides control, each replicated thrice. All the treatments were applied in the soil at the rate of 1.5 kg ai/ha at the time of transplanting. Dust and granular formulations were applied uniformly on the bunds prepared for transplanting while the required amount of EC formulation diluted in 1 lit of water was applied with the help of hand sprayer. Observations on plant height, wilting and yield were recorded. In a duplicate set of experiment, five randomly selected plants were uprooted to count the subterranean population at different intervals. All visible stages *viz.*, different larval instars, pupae and teneral adults were taken into account. Data on plant height, percentage wilting, yield and grub population thus obtained were subjected

to statistical analysis. For working out the economics of different treatments, prevailing rates at the local market during the period of study were taken into account. Simple correlation and regression were worked out between grub population and various plant growth parameters *viz.*, plant height, wilting and yield.

RESULTS AND DISCUSSION

Results summarised in Table 1 indicate that all the insecticides tested were significantly superior over control in reducing the population of grubs. Aldicarb was most effective with a mean grub population of 1.33 per plant as compared to 13.67 per plant in control. Phorate and carbofuran did not differ significantly from aldicarb. Wilting percentage was minimum in the case of aldicarb (4.65), followed by phorate (10.06), carbofuran (19.12), aldrin (27.27),

TABLE 1. Efficacy of different treatments in controlling the grubs of *Myllocerus subfasciatus* Guerin.

Treatment	Plant height (cm) (45 DAP)	(85 DAP)	Grub population (85 DAP)	Wilting (%)	Yield (kg/plot)
Aldicarb (Temik 10G)	10.59	65.17^{a}	1.33^{a}	4.65 (12.98)^{a}	9.82^{a}
Phorate (Thimet 10G)	9.67	63 73^{a}	1.87^{a}	10.06 (18.84)^{b}	7.91^{b}
Carbofuran (Furadan 3G)	11.48	61.99^{a}	1.87^{a}	19.12 (25.96)^{c}	9.15^{ab}
Quinalphos (Ekalux 5G)	9.70	45.53^{b}	6.60^{c}	35.08 (36.55)^{d}	4.95^{c}
Aldrin (5% dust)	9.07	46.35^{b}	4.53^{b}	27.27 (31.80)^{cd}	4.91^{c}
Lindane (Lintaf 20 EC)	8.79	42.55^{b}	6.00^{bc}	28.60 (32.55)^{d}	6.11^{c}
Control	8.19	29.53^{c}	13.67^{d}	50.37 (45.51)^{e}	3.07^{d}
C D 5%	N S	6.112	1.718	5.837	1.293

Note: 1. Treatment means followed by the same alphabets are not significantly different. 2. Grub population includes total grubs, pupae and teneral adults. 3. DAP = Days after planting. 4. Figures in paranthesis are transformed values ($\sin^{-1}\sqrt{x}$)

TABLE 2. Economics of different treatments used for the control of *Myllocerus subfasciatus* Guerin.

Treatments	Yield Q/ha	Additional yield Q/ha	Additional income Rs/ha	Treatment cost Rs/ha	Net income Rs/ha	Benefit/cost ratio
Aldicarb (Temik 10G)	81.83	56.25	4500=00	756=50	3743=50	5.94
Phorate (Thimet 10G)	65.92	40.34	3227=20	340=60	2886=70	9.47
Carbofuran (Furadan 3G)	76.25	50.67	4053=60	806=50	3247=10	5.02
Quinalphos (Ekalux 5G)	41.25	15.67	1253=60	636=50	617=10	1.97
Aldrin (5% dust)	40.92	15.34	1227=20	198=50	1028=70	6.18
Lindane (Linta 20 EC)	50.92	25.34	2027=20	231=50	1795=70	8.71
Control	25.58	—	—	—	—	—

Note: 1. Treatment cost includes actual cost of insecticide plus labour charge @ Rs. 6.50/man day. 2. Cost of brinjal has been calculated @ Rs. 0.80/kg.

TABLE 3. Correlation coefficient (r) between grub population and various plant growth parameters.

Factors	Correlation coefficient (r)	Regression equation
Grub population (X) and plant height (Y)	−0.9350**	Y = 65.6448 − 2.9176 x
Grub population (X) and wilting (Y)	+0.9118**	Y = 7.6732 + 3.3855 x
Grub population (X) and yield (Y)	−0.8744**	Y = 9.2068 − 0.5167 x

**Significant at 1%

lindane (28.60), quinalphos (35.08) and control (50.37). There was no significant difference among treatments for plant height after 45 days of transplanting but all the treatments showed significantly more plant height than control after 85 days of transplanting. This may be attributed to initial low grub infestation in control. Maximum yield (kg/plot) was also recorded in aldicarb (9.82) closely followed by carbofuran (9.15) and phorate (7.91). Other treatments also resulted significantly higher yield over control. Results on the economics of different treatments are presented in Table 2. It is apparent that additional net income was maximum in aldicarb and minimum in quinalphos. The benefit cost ratio was, however, maximum for phorate (9.47) followed by lindane (8.71), aldrin (6.18) and aldicarb (5.94).

Thus, all the treatments were significantly superior over control in reducing the grub population and wilting and increasing the plant height and yield. Aldicarb was, however, best with least population and maximum yield. In literature, no information is available to compare the results. AYYAR (1963), however, recommended dusting or spraying of Calcium, Magnesium, Lead arsenate of DDT for the control of adult ashweevils infesting brinjal leaves.

Results of correlation and regression between grub population and various plant growth parameters are presented in Table 3. Significant positive correlation (r = + 0.9118) was observed between the grub population and wilting while significant negative correlation was observed between grub population and plant height (85 DAP) and grub population and yield. Wilting of the brinjal plants as a consequence of higher grub population has also been reported earlier (SIDDAPPAJI, 1976).

Acknowledgement:—The authors are thankful to Dr. K. L. Chadha, Director, Indian Institute of Horticultural, Research, Banglore for providing necessary facilities for the experiment.

REFERENCES

AYYAR, T. V. R. (1920) Some insects recently noted as injurious in South India. *Rept. Proc. 3rd Ent. Mtg.*, 1, 315—417.

AYYAR, T. V. R. (1963) *Handbook of Economic Entomology for South India.* Controller of stationery and printing, Govt. of Madras, pp. 516.

KALYANAM, N. P. (1967) *Common Insects of India.* Asia Publishing House, Madras, pp. 116.

SIDDAPPAJI, C. (1976) Studies on the fauna of *Myllocerus* in Karnataka and biology of *Myllocerus discolor* Boheman (Coleoptera: Curculionidae). M. Sc. (Ag.) thesis, Dept. of Entomology, UAS, Bangalore.

UTHAMASAMY, S., M. GOPALAN & D. VENKATA NARAYANAN (1973) Laboratory evaluation of new chemicals for the control of spotted leaf beetle and the ashweevil damaging leaves of brinjal. *Madras agric. J.*, 60 (7), 611.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 83 *to* 86

RELATIONSHIP BETWEEN SIZE OF *EUCELATORIA BRYANI* SABROSKY FEMALES AND THEIR LONGEVITY AND FECUNDITY

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Superparasitism is commonly observed in mass breeding *Eucelatoria bryani* Sabrosky resulting in puparia of different sizes. Longevity, larviposition period, number of progeny produced and ovarian development were studied in female flies emerging from puparia which weighed 6.5, 10, 15, 20, 25 and 30 mg. The smallest fly emerged from puparium weighing 6·5 mg lived for 15.25 days, while the largest one emerged from 30 mg puparium lived for 29.75 days. A mean of 6, 13.75, 26.75, 42.50, 48.5 and 54.25 puparia were produced by the female flies which had emerged from puparia weighing 6.5, 10, 15, 20, 25 and 30 mg respectively. Larviposition period increased from 3.5 to 13 days with increase in the size of female. The dissection of mated females revealed that a mean of 17.0 and 81.50 eggs+maggots were observed in the ovaries of the flies emerging from the puparia weighing 6.5 and 30 mg respectively.

(Keywords: relationship, size, *Eucelatoria bryani*, longevity, fecundity)

INTRODUCTION

In recent years increased interest has been evinced in the use of tachinids in biological control (CHAUTHANI & HAMM, 1967; BRYAN *et al.*, 1969; JACKSON *et al.*, 1969 b, BENNET, 1969; HUGHES, 1975). Several tachinid parasites were reported from *Heliothis armigera* (Hubn.) in India by RAO (1968), PATEL *et al.*, (1970) and PATEL & SINGH (1972) but these flies are unable to keep this pest under check. The tachinid, *Eucelatoria bryani* Sabrosky was therefore imported from the U S A through the Common Wealth Institute of Biological Control for trials against *H. armigera* (SANKARAN & NAGARAJA, 1979).

Different sizes of puparia of this tachinid were obtained in the course of mass breeding. This variation resulted from the age of the host, length of exposure of host to the fly (which determines the number of maggots laid) and the host-parasite ratio (which influence superparasitism). The effects of superparasitism on length of development, puparial weight and adult emergence of *Eucelatoria* sp. were studied by ZISER *et al.* (1977) who also suggested that the fecundity of females of different sizes should be studied. With this in view and also to obtain additional information on the biology of *E. bryani* to facilitate more efficient rearing, the present study was undertaken.

MATERIALS AND METHODS

H. armigera was maintained on an artificial diet developed by NAGARKATTI & SATYAPRAKASH

* Previously referred to as *E. armigera* (Jackson *et. al.*, 1969), *Eucalatoria* sp. (Bryan *et. al.*, 1972 and Ziser and Nettles, 1972) and *E.* sp. nr. *armigera* (Sankaran and Nagaraja, 1979).
Contribution No. 1033 of the Indian Institute of Horticultural Research, Bangalore-80.

(1974) and the culture of *E. bryani* as described by JACKSON *et al.* (1969 a). The size of the fly is represented in terms of puparial weight. To ensure large variation in size of the puparia four batches containing 50 fourth instar larvae were exposed in the cages (30×30×30 cm) to 50 mated females for ten minutes to two hours. Puparia recovered from parasitised larvae were weighed. Puparial weight below 6 mg and above 30 mg is uncommon. Hence, twenty puparia in each group weighing 6.5, 10, 15, 20, 25 and 30 mg were kept for adult emergence in individual glass vials (7.5×2.5 cm). This study was carried out in the laboratory at 30 ± 1.6°C and 55—60% R H. Immediately after emergence, the females were released individually into a cage with males for mating. Four mated females in each group were kept individually in small cages (13×9×13 cm). Seven days after mating, early fourth instar larvae were offered to the flies daily at 1000, 1200, 1400 & 1600 hr. The larvae in which haemolymph oozed out from the punctures due to larviposition by the parasite were kept for observation and the puparia obtained were recorded six days after parasitisation. Those mated females which were used for parasitisation, were utilised for longevity studies also. To observe the ovarian development, another set of four mated females in each group were dissected 10 days after mating. Total number of eggs+maggots present in individual females were counted

A simple randomised block design was employed to analyse the differences in longevity, larviposition period, number of larvae parasitised and puparia produced by a single female and number of eggs + maggots present in a single female.

RESULTS AND DISCUSSION

In the present study the puparial weight ranged from 4.5 to 36 mg while ZISER *et al.* (1977) reported a range of puparial weight from 9.2 to 27.2 mg in *E. bryani.*

There was significant difference in the longevity of females of different sizes (Table 1). The smallest fly (6.5 mg) lived for 15.25 days, while the largest one (30 mg) lived for 29.75 days. This is in agreement with the findings of SANKARAN & NAGARAJA (1979) who reported that superparasitism in *E.* sp. nr. *armigera* produced smaller and short-lived adults. BRYAN *et al.* (1972) found that the mean longevity of females varied from 18 to 62 days at different temperatures.

TABLE 1. Longevity and duration of larviposition period in *Eucelatoria* sp. nr. *armigera* females of different sizes.

No.	Puparial weight	Female longevity* (Days)	Larvipositon period* (Days)
1.	6.5	15.25±0.83	3.50±0.87
2.	10.0	2100.±1.22	8.00±0.71
3.	15.0	22.75±0.84	9.75±1.30
4.	20.0	25.00±0.71	10.75±0.43
5.	25.0	26.75±1.11	11.50±0.50
6.	30.0	29.75±1.10	13.00±0.74
Level of significance		6.01	0.01
C D (P = 0.05)		3.67	2.90

*Mean of four flies.

The larviposition period of flies of different sizes increased with increase in the size of females. Flies emerging from the puparia of 6.5, 10, 15, 20, 25 and 30 mg had larviposition periods of 3.5, 8, 9.75, 10.75, 11.5 aud 13 days respectively on an average. BRYAN *et al.*, (1972) reported that the actual larviposition period in *Eucelatoria* sp. varied from one to 29 days at different temperatures.

Small flies emerging from puparia of 6.5 mg weight parasitised only six larvae while large flies parasitized as many as 31.75 larvae on an average. As shown in Table 2, differences among the different sizes of females were significant. Total production of puparia by individual females increased significantly with increase in the size of *E. bryani* females. A mean of 6, 13.75, 26.75, 42.5, 48.25 and 54.25

TABLE 2. Progeny production of *Eucelatoria* sp. nr. *armigera* of different sizes.

No.	Puparial weight (mg)	*Number of larvae parasitised	*Number of puparia produced	*Number of eggs + maggots present in a female not allowed to larviposit.
1.	6.5	6.00 ± 0.83	6.00 ± 0.85	17.00 ± 1.87
2.	10.0	11.00 ± 1.23	13.75 ± 1.09	26.25 ± 2.39
3.	15.0	22.75 ± 1.30	26.75 ± 1.66	38.75 ± 2.59
4.	20.0	26.50 ± 0.71	42.50 ± 1.12	55.00 ± 4.06
5.	25.0	28.75 ± 0.83	48.25 ± 1.98	74.25 ± 2.89
6.	30.0	31.75 ± 2.05	54.25 ± 2.68	81.50 ± 2.29
Level of significance		0.01	0.01	0.01
C D (P = 0.05)		4.40	6.04	9.64

* Mean of four flies.

puparia were produced by the female flies which had emerged from puparia weighing 6.5, 10, 15, 20, 25 and 30 mg respectively. There was no significant difference in the fecundity of flies which had emerged from puparia weighing 25 and 30 mg. KING *et al.* (1976) also observed that the relationship between female fly size and egg production was linear, with egg production increasing with increasing fly weight in *Lixophaga diatraeae* (Townsend) ETIENNE (1972) first demonstrated that egg production by *L. diatraeae* was related to female size and MCPHERSON (1975) also showed that maggots reared on large host larvae (resulting in larger puparia) produced flies with higher reproductive potential. The present findings are therefore are in conformity with those of the above authors.

The dissection of mated females indicated significant variation in the number of eggs + maggots present in individual flies (Table 2). A minimum of 17 were observed in flies emerging from small (6.5 mg) puparia and the maximum mean number of 81.50 was recorded in the largest emerging from large (30 mg) puparia. The number of maggots in an individual depends on the size of the adult as suggested by JAI RAO & BALLIGA (1968) in their studies on *Sturmiopsis inferens* (Towns.)

However, in the present study the production of progeny of a single female irrespective of size was very low when compared to 112 puparia at 30°C produced by a single female of *Eucelatoria* sp as reported by BRYAN *et al.* (1969). The low production of progeny in the present study may be due to the change over from the natural hosts *H. virescens* (F.) and *H. zea* (Boddie) to *H. armigera* (SANKARAN & NAGARAJA, 1979).

Acknowledgements: The authors are grateful to Mr. B. Manohar and Mr. K. Gopalakrishnan of Biological Control Laboratory for their help in the present investigation and Dr. T. Sankaran, Entomologist-in-charge, Commonwealth Institute of Biological Control, Indian Station, Bangalore for going through the manuscript. They are also thankful to the Director, Indian Institute of Horticultural Research, Bangalore.

REFERENECS

BENNET, F. D. (1969) Tachinid flies as biological control agents for sugarcane moth borers, 117—148, *in, Pests of Sugarcane* (J. R. WILLIAMS, J. R. METACALF, R. W. MUNGOMERY and R. MATHS Eds.) New York, Elsevier Publishing Company.

BRYAN, D. E., C. G. JACKSON & R. PATANA (1969) Effect of temperature on progeny production and longevity of *Lespesia archippivora* in the laboratory. *J. econ. ent.*, **62**, 765 – 767.

BRYAN, D. E., C. G. JACKSON, E. C. NEEMANN & R. PATANA (1972) Production of progeny and longevity of *Eucelatoria* sp. parasitic on *Heliothis* species. *Env. ent.*, **1**, 23—26.

CHAUTHANI, A. R., & J. H. HAMM (1967) Biology of the exotic parasite *Driono munda* (Diptera: Tachinidae). *Ann. ent. Soc. Am.* **60**, 373—376.

ETIENNE, J. (1972) *Lixophaga diatraeae* Tourns reared on non-congeneric lepidopterous hosts. *Proc. Int. Soc. Sugarcane Technol.*, **14**, 496—502.

HUGHES, P. S. (1975) The biology of *Archytas marmoratus* (Towns.). *Ann. ent. Soc. Am.*, **68**, 759—767.

JACKSON, C. G., D. E. BRYAN & R. PATANA (1969 a) Laboratory studies of *Eucelatoria armigera*, a tachinld parasite of *Heliothis* spp. *Ann. ent. Soc. Am.*, **62**, 907—910.

JACKSON, C. G., C. D. BUTLER & D. E. BRYAN (1969 b) Time required for development of *Voria ruralis* and its host cabbage looper at different temperatures. *J. econ. Ent.*, **62**, 6)—70.

IAI RAO, K. & H. BALLIGA (1968) *Sturmiopsis inferens* Towns, a tachinid parasite of sugarcane and paddy stem borers. *Tech. Bull. Commonw. Inst. biol. Control*, **10**, 129—149.

KING, E. G., L. R. MILES & D. F. MARTIN (1976) Some effects of Superparasitism by *Lixophaga diatraeae* of sugarcane borer larvae in the laboratory. *Ent. exp. et appl.*, **20**, 261—269.

MCPHERSON R. M. (1975) The potential of *Lixophago diatraeae* Towns. (Diptera : Tachinidae) for control of *Diatraea saccharilis* F. (Lepidoptera : Pyralidae) in Louisiana. M. S. Thesis, Louisiana, State University Library, Baton Rouge. LA. 15—17.

NAGARKATTI, S. & SATYA RAKASH (1974) Rearing *Heliothis armigera* (Hub.) on artificial diet. *Tech. Bull. Commonw. Inst. biol. Control.*, **17**, 169—173.

PATEL, R. C. & R. SINGH (1972) Biology and breeding method of of *Goniolphthalmus halli* Mesnil (Diptera : Techinidae), a larval parasite of *Heliothis armigera* (Hubn). *Indian J. agric. Sic.*, **42**, 739—743.

PATEL, R. C., R. SINGH & P. B. PATEL (1970) Bionomics of *Carcelia illota* (Curren), a tachinid parasite of *Heliothis armigera* (Hubn) larvae. *Bull. ent Res.*, **11**, 161—168.

RAO, V. P. (1968) *Heliothis* spp. and their parasites in India. *PANS*, **14**, 367—375.

SANKARAN, T. & H. NAGARAJA (1979) A note on *Eucelatoria* sp. nr. *armigera* (Coq.) (Cidp., Tachinidae) imported from U. S. A., for trial against *Heliothis armigera* (Hub) (Lep , Noctuidae) in India. *Entomon*, **4**, 379—381.

ZISER, S. W., J. A. WOJ TOWCIZ & W. E. NETTLES (1977) The effects of the number of maggots per host on length of development, puparial weight and adult emergence of *Eucelatoria* sp. *Ann. ent. soc. Am.*, **70**, 733—736.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 87 *to* 92

SUSCEPTIBILITY OF TWO BRACONID PARASITES *APANTELES ANGALETI* MUESEBECK AND *BRACON KIRKPATRICKI* (WILKINSON) TO SEVERAL CHEMICAL PESTICIDES

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(Received 31 August 1982)

The susceptibility of two braconid parasites of pink bollworm, *Apanteles angaleti* Muesebeck (an indigenous species) and *Bracon kirkpatricki* (Wilkinson) imported into India from Africa to seventeen pesticides (carbaryl, chlorpyriphos, dichlorvos, dicofol, dimethoate, Dithane Z-78, endosulfan, fenitrothion, malathion, methomyl, methyl demeton, monocrotophos, phosalone, phosphamidon, quinalphos, thiometon and sulphur) at field recommended dose· was determined under laboratory conditions. Phosalone (0.05%) was found to be non-toxic to the adults and immaurs stage of *A. angaleti* and *B. kirkpatricki*. Phosphamidon (0.10%) proved to be less toxic to *A. angaleti* but highly toxic to *B. kirkpatricki*. All the remaining insecticides showed high toxicity to the adults of both the parasites resulting in 100% mortality within 1—6 hr exposure. The fungicides Dithane Z—78 and wettable sulphur (both at 2g/litre) and the acaricide dicofol (0.05%) proved non-toxic to *A. angaleti and B. kirkpatricki*. (*Key words: Apanteles angaleti, Bracon kirkpatricki*).

INTRODUCTION

The pink bollworm, *pectinophora gossypiella* (Saunders) is one of the most destructive pests of cotton in several parts of the world. Pesticides do not provide satisfactory control of this pest. Moreover, insecticide treatments applied for pink bollworm control have frequently aggravated other insect pest problems in cotton. Utilisation of biological control agents along with selective insecticides would appear to be the preferred alternative in combating this pest. Cultures of two biological control agents of pink bollworm, *Apanteles angaleti* Muesebeck and *Bracon kirkpatricki* (Wilkinson) are being maintained at the Indian Institute of Horticultural Research under the All India Co-ordinated Research Project on Biological Control of crop pests and weeds, with a view to using them for pink bollworm control in India. *A. angaleti* is an important indigenous larval parasite while *B. kirkpatricki*, another larval parasite of pink bollworm has been imported from Africa. The present study was conducted to obtain some information on the susceptibility of these two parasites to several commonly used pesticides and eventually to select those that appear safe for use in integrated control programmes.

Contribution No. 115/82 of the Indian Institute of Horticultural Research, Bangalore 560 080.

MATERIALS AND METHODS

The rice moth, *Corcyra cephalonica* (STAINT) maintained in the laboratory, was used as alternate host for rearing *A. angaleti* and *B. kirkpatricki*. *A. angaleti* was reared by adopting the method as described by NARAYANAN *et al.* (1956) whereas *B. kirkpatricki* was multiplied as suggested by BRYAN *et al.* (1969). Since the adult stage of parasites is ordinarily more susceptible to pesticide treatments, one day old females of

both the parasites were used as test insects as suggested by GAITONDE (1978).

Seventeen pesticides, of which several are commonly used to Control cotton pests and were tested in the laboratory. They are: carbaryl (Bangvin 50 WP), chlorpyriphos (Dursban 25 EC), dichlorvos (Nuvan 100 EC), dicofol (Kelthane 18.5 EC), dimethoate (Rogor 35 EC), Dithane Z-78, endosulfan (Thiodan 35 EC), fenitrothion (Folithion 50 EC), malathion (cythion 50 EC), methomyl (Lannate 20 EC), methyl demeton (Metasystox 25 EC), monocrotophos (Nuvacron 40 EC), phosalone (Zolone 35 EC), quinalphos (Ekalux 25 EC), sulphur (Microsulf 80 WP) and thiometon. Field recommended concentration/dose for each chemical was selected for the treatment. Formulated materials of the above pesticides were diluted with water to get the desired concentration.

Toxicity of the pesticides to the parasites was tested by dry film technique. A 12×2 cm strip of filter paper was dipped in the prepared pesticide sulution and allowed to dry uuder sun for about 10-15 minutes. An untreated check was maintained by dipping the filter paper in water alone and drying under sun to correct the mortality in the treatments. After drying, the filter paper strip was kept in a glass vial (15×2.5 cm) and ten adult parasites were introduced into the vial (WILKINSON *et al.*, 1975). The adults were fed with 50% honey during the testing period and the mouth of the vial was covered with muslin to provide sufficient aeration. The parasites were exposed to the treatment continuously for a period of six hours, then transferred to untreated glass vials and held for a further 24 hr for observation as suggested by GAITONDE (1978). Mortality of the parasites was observed at 1, 2, 4 and 6 hr during the exposure and then for 24 hr following treatment. Each chemical treatment was replicated three times and each replicate consisted of ten females.

Zero values in the percentage mortality of the adult parasites were converted into 0.01 and then data were transformed into corresponding angles (arc-sine $\sqrt{\text{percentage}}$) for statistical analysis. Differences in the mortality of the parasites due to different pesticides were analysed using 'F' test.

The susceptibility of immature stages of the above parasites to phosalone (safer to both) and phosphamidon (safer to *A. angaleti)* was also studied. Spraying of these two chemicals was two done when the parasite grubs started forming cocoons. In case of *A. angaleti*, sorghum grains infested with a known number of *Corcyra* larvae exposed to the parasite were sprayed on 13th day of exposure. In case of *B. kirkpatricki*, facial tissue paper sheets containing *Corcyra* larvae with a known number of grubs/cocoons were sprayed on 7th day of exposure. Untreated checks sprayed with water were also kept. The sprayed sorghum grains and the tissue papers were dried and emergence of adult parasites was observed.

RESULTS

The susceptibility of adult *A. angaleti* to different pesticides varied significantly (Table 1). Among the insecticides tested, phosalone had no effect on this parasite and phosphamidon was found to be less toxic than the remaining insecticides. With phosphamidon, there was no mortality upto 4 hr of exposure, 10% mortality after 6 hr of exposure and 13.3% during the post treatment period of 24 hr. It was also observed that emergence of adults of *A. angaleti* was not effected by the spray application of phosalone and phosphamidon on the immature stages of the above parasite (Table 3). Of Dithane Z-78, dicofol and sulphur were totally non-toxic to *A. angaleti*. The remaining chemicals, chlorpyriphos and dichlorvos caused 100% mortality after one hour of exposure; carbaryl, endosulfan, malathion and quinalphos caused 100% mortality after 2 hr of exposure; dimethoate, fenitrothion and methyl demeton caused 100% mortality after 4 hr of exposure. With methomyl, monocrotophos and thiometon 100% mortality of *A. angaleti* was observed after 6 hr of exposure.

The contact toxicity of different pesticides to the adults of *B. kirkpatricki* varied considerably (Table 2). Phosalone was found to be non-toxic to this parasite. Immature stages (grubs and cocoons) of *B. kirkpatricki* were also not affected by

TABLE 1. Effect of various pesticides on adults of *A. angaleti* (figures in parenthesis are transformed values).

Sl. No.	Pesticide		% Mortality				During 24 hr of post treatment
			Duration of exposure in hours				
			1	2	4	6	
1.	Carbaryl	0.10%	40.0 (39.7)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
2.	Chlorpyriphos	0.05%	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
3.	Dichlorvos	0.10%	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
4.	Dimethoate	0.05%	0.0 (0.6)	0.0 (0.6)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
5.	Endosulfan	0.05%	90.0 (75.4)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
6.	Fenitrothion	0.05%	0.0 (0.6)	93.3 (81.3)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
7.	Malathion	0.10%	80.0 (64.5)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
8	Methomyl	0.05%	0.0 (0.6)	23.3 (24.7)	86.7 (69.4)	100.0 (90.0)	100.0 (90.0)
9.	Methyl demeton	0.05%	0.0 (0.6)	73.3 (60.3)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
10.	Monocrotophos	0.05%	0.0 (0.6)	0.0 (0.6)	66.7 (55.6)	100.0 (90.0)	100.0 (90.0)
11.	Phosphomidon	0.10%	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	10.0 (15.6)	13.3 (18.3)
12.	Phosalone	0.05%	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)
13.	Quinalphos	0.05%	60.0 (51.4)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
14.	Thiometon	0.05%	0.0 (0.6)	0.0 (0.6)	56.7 (49.8)	100.0 (90.0)	100.0 (90.0)
15.	Dicofol	0.05%	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)
16.	Dithane Z-78	2 g/ ltr	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)
17.	Sulphur	2 g/ ltr	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)

Comparison of significant effects	*level of significance*	*C D ($p = 0.05$)*
Between treatments	0.01	3.24
Between periods	0.01	1.76
Interaction between treatment and period	0.01	7.25

TABLE 2. Effect of different pesticides on adults of *B. kirkpatricki* (Figures in parenthesis are transformed values).

Sl. No.	Pesticide		% Mortality				During 24 hr of post treatment
			Duration of exposure in hours				
			1	2	4	6	
1.	Carbaryl	0.10%	33.3 (35.8)	53.3 (46.2)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
2.	Chlorpyriphos	0.05%	0.0 (0.6)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
3.	Dichlorvos	0.10%	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
4.	Dimethoate	0.05%	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	100.0 (90.0)	100.0 (90.0)
5.	Endosulfan	0.05%	83.3 (66.7)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
6.	Fenitrothion	0.05%	53.3 (49.4)	73.3 (61.8)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
7.	Malathion	0.10%	0.0 (0.6)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
8	Methomyl	0.05%	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
9.	Methyl demeton	0.05%	0.0 (0.6)	0.0 (0.6)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
10.	Monocrotophos	0.05%	0.0 (0.6)	0.0 (51.4)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
11.	Phosphomidon	0.10%	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	76.7 (62.3)	100.0 (90.0)
12.	Phosalone	0.05%	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)
13.	Quinalphos	0.05%	0.0 (0.6)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
14.	Thiometon	0.05%	0.0 (0.6)	0.0 (0.6)	100.0 (90.0)	100.0 (90.0)	100.0 (90.0)
15.	Dicofol	0.05%	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)
16.	Dithane Z-78	2 g/ ltr	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)
17.	Sulphur	2 g/ ltr	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)	0.0 (0.6)

Comparison of significant effects	*level of significance*	*C D ($p = 0.05$)*
Between treatments	0.01	1.14
Between periods	0.01	0.67
Interaction between treatment and period	0.01	2.55

TABLE 3. Effect of phosalone and phosphamidon on immature stages of *A. angaleti* and *B. kirkpatricki*

Treatment	*A. angaleti*		*B. kirkpatricki*		
	No. of host larvae	No. of parasites emerged	No. of grubs/ cocoons treated	No. of adults emerged	% emergence
Phosalone	100	48	93	77	82.8
Phosphomidon	100	49	90	0	0.0
Control (water)	100	45	74	65	87.8

the application of phosalone, and 82.80% of adult emergence from treated immature stages was observed. With phosphamidon, grubs and cocoons were completely killed resulting in no adult emergence (Table 3). Dicofol, Dithane Z-78 and sulphur also did not have any effect on the adult parasites. All the remaining chemicals proved extramely toxic to *B. kirkpatricki*. With dichlorvos and methomyl 100% mortality occurred after one hour of exposure. Chlorpyriphos, endosulfan, malathion and quinalphos caused 100% mortality after 2 hr of exposure. There was 100% mortality with carbaryl, methyl demeton, monocrotophos and thiometon after 4 hours of exposure. Dimethoate caused 100% mortality after 6 hr of exposure. With phosphamidon there was no mortality upto 4 hr of exposure and 76.7% mortality after 6 hr of exposure and 100% mortaity during the post treatment period of 24 hr.

DISCUSSION

Phosalone has been described as a very effective insecticide against the major pests of cotton (SELLAMMAL & PARAMESWARAN, 1979). The non-toxic/less toxic nature of phosalone to several hymenopteran parasites like *Aphidencyrtus aphidtvorus* (Mayr), *Aphidius ervi* Haliday, *Encarsia formosa* Gahan, *Tetrastichus* sp., *Trichogramma evanescens* Westwood and *T. minutum* Riley was reported by LELIEVRE (1980). In the present study it proved non-toxic to indigenous as well as exotic parasites of pink bollworm. The authors also observed in another study (MANI & NAGARKATTI, in press) that phosalone was least toxic to *Eucelatoria bryani* Sabrosky, a larval parasite of the cotton bollworm *Heliothis* spp. Hence phosalone appears to have potential for use in integrated control programmes in cotton, since it appears to be non-toxic/ less toxic to both dipterous and hymenopterous parasites.

All the remaining insecticides ie., carbaryl, chlorpyriphos, dichlorvos, dimethoate, endosulfan, fenitrothion, malathion, methomyl, methyl demeton, monocrotophos, quinalphos and thiometon were highly toxic to both *A. angaleti* and *B. kirkpatricki*. The harmful effect of dimethoate, endosulfan, phosphamidon and carbaryl to five parasitic hymenoptera has also been reported by BARTLETT (1963).

Both the fungicides ie , Dithane Z-78 and sulphur and the acaricide dicofol proved non-toxic to *A. angaleti* and *B. kirkpatricki*, which corroborates the findings of BARTLETT (1963, 1966) who also

found that these chemicals were non-toxic or less toxic to some hymenopteran parasites.

From this study it is also evident that no generalizations regarding safety of insecticides to any parasites can be made, since two parasites from the same family (Braconidae) responded quite differently to some of the insecticides. It is therefore desirable to test individual insecticides against all the natural enemy species in an ecosystem before drawing any conclusions.

Acknowledgements: The authors acknowledge the help rendered Mr. M. B. Biradar and Mr. Clement Peter during this study. They are also grateful to Director, Indian Institute of Horticultural Research, Bangalore for providing facilities to conduct this research.

REFERENCES

Bartlett, B. R. (1963) The contact toxicity of some pesticide residues to hymenopterous parasites and coccinellid predators. *J. econ. Ent.*, 56, 694—698.

Bartlett, B. R. (1966) Toxicity and acceptance of some pesticides fed to parasititic hymenoptera and predatory coccinellids. *J. econ. Ent.*, 59, 1142—1149.

Bryan, D E., C. G. Jackson, A. Stoner (1969) Rearing cotton insect parasites in the laboratory. *U. S. Dept. Agr. Prod. Res. Rpt*, 109, 13pp.

Gaitonde, B. B. (1978) Protocol for toxicity to parasites/predators. Report of the sub-committee on pesticide toxicology submitted to Ministry of Agriculture and Irrigation, New Delhi (India), 136 pp.

Lelievre, D. (1980) The side-effects of phosalone. Paper presented at 32nd International Symposium on Plant protection, Ghent, 6th May, 1980.

Mani, M. & S. Nagarkatti (1981) Response of the parasitoid *Eucelatoria bryani* Sabrosky (Diptera: Tachinidae) to different pesticides. *Colemania* (in press).

Narayanan, E. S., B. R. Subba Rao & G. A. Gangrade (1956) The biology and rate of reproduction and the morphology of the immature stages of *Apanteles angaleti* Muesebeck. *Beitr. Ent.*, 6, 296—320.

Sellammal, M. & S. Parameswaran (1979) Effect of insecticides on the control of bollworms and yield of *MCUS* cotton under irrigated conditions. *Pesticides*, 13(2), 25—27.

Wilkinson, J. D., K. D. Biever & C. M. Ignoffo (1975) Contact toxicity of some chemical and biological pesticides to several insect parasitoids and predators. *Entomophaga*, 20, 113—120.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 93 *to* 96

BRIEF COMMUNICATION

NEW APHID PARASITOIDS (HYMENOPTERA : APHIDIIDAE) FROM WEST BENGAL, INDIA

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(Received 31 August 1982)

One new genus *Neoephedrus* and its two species *N. helichrysi* and *N. kalimpongensis* of the family Aphidiidae are described.

(Keywords: aphid parasitoids, new genus, new species)

So far 82 aphidiid species are known from the Indian subcontinent (Takada and Rishi, 1980; Agarwala *et al.*, 1981; Saha *et al.*, in press; Stary and Raychaudhuri, in press).

Survey for aphid parasitoids made during March-May 1982 in Darjeeling, West Bengal, has resulted in the find of a new genus *Neoephedrus* and its two new species *N. helichrysi* and *N. kalimpongensis* These are described. Through the present work, Indian Aphidiidae is now known to be represented by 84 species.

Materials are in the collection of Entomology Laboratory, Dept. of Zoology, Calcutta University.

Neoephedrus n.gen

Description : Head squarish; eyes slender; antennae 20-26 segmented, filiform; propodeum almost smooth, laterally with minute warts, irregularly carinated; pterostigma triangular; radial cells separated: inter-radial veins I and II present; tergite I slender; genitalia with leaf like hairy ovipositor sheath and more or less straight, hairless, apically toothed and pointed ovipositor.

Remarks: This new genus approaches close to the genus *Ephedrus* Haliday and its allied genera, viz., *Parephedrus* Haliday and *Lysiephedrus* Stary, in having similar: 1) tergite 1, 2) head shape and 3) wing venation. But it stands distinct from the mentioned genera in: 1) genitalia, 2) propodaeum and 3) antennal segmentation.

Type-species: *Neoephedrus helichrysi*
The new genus comprises two species: *Neoephedrus helichrysi* and *N. kalimpongensis.*

Neoephedrus helichrysi n. gen. et n. sp (Fig. 1: A—F)

Description of the female: Head (Fig. 1D) squarish; slightly narrowed beyond eyes, with short and long dense hairs; temple $\frac{1}{4}$ lesser than transverse eye diameter; gena nearly $\frac{1}{2}$ longitudinal eye

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Abbreviations used: IOL = Interocular line; FL = Facial line; HW = Head width; TFL = Transfacial line; ITL = Intertentorial line; TOL = Tentoriocular line; GW = Width of gena; SD = Socket diameter; SOL = Socket ocular line; VED = Vertical eye diameter; LED = Longitudinal eye daimeter; F_1L = F_1 length; F_1B = F_1 breadth; F_2L = F_2 length; F_2B = F_2 breadth; PL = Pterostigma length; PW = Pterostigma width; MC = Metacarpus; Tergite I : L = length, B = Breadth.

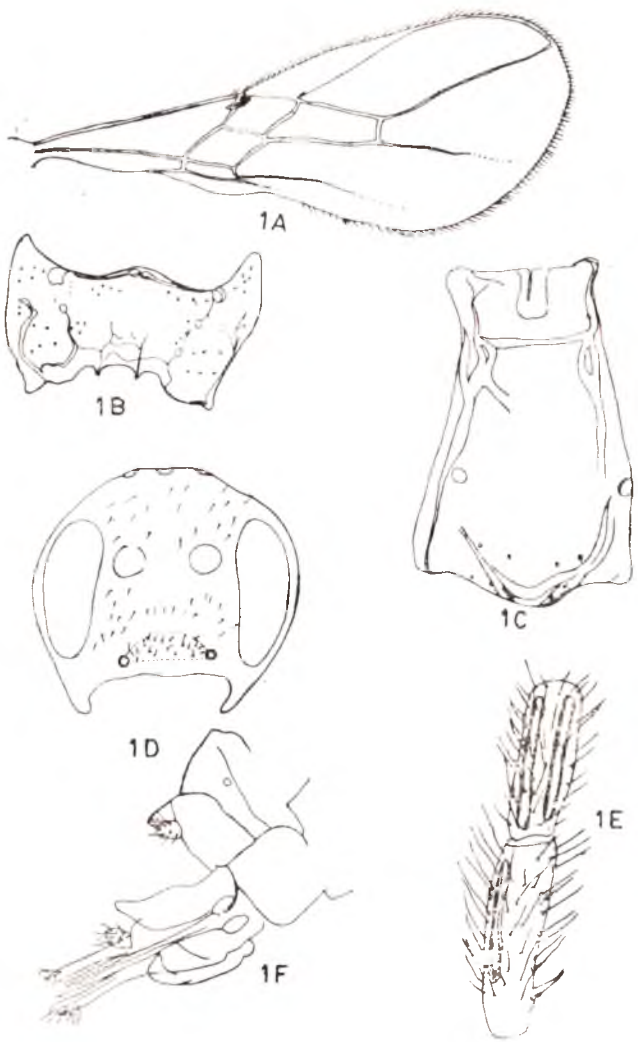

Fig. 1. A—F: *Neoephedrus helichrysi* n.gen. et.n.sp.
A. Wing; B. Propodaeum; C. Tergite 1; B. Head;
E. Genitalia; F. F_1 & F_2 of Antenna.

diameter; interocular line $\frac{1}{3}$ longer than transfacial line and little longer than facial line; clypeus with about 20 long hairs; tentoriocular line $\frac{1}{3}$ lesser than $\frac{1}{2}$ intertentorial line. Antennae 24-26 segmented, filiform, densely long haired. F_1 $\frac{1}{4}$ longer than F_2 (Fig. 1E) nearly 4 times as its width; socket ocular line little shorter than socket diameter; eyes slender.

Notaulices absent; propodaeum (Fig. 1B) with a pair of spiracles, almost smooth except a few irregular transverse carinae restricted at lower part, sparsely hairy, $\frac{1}{2}$ or little more so wide as long.

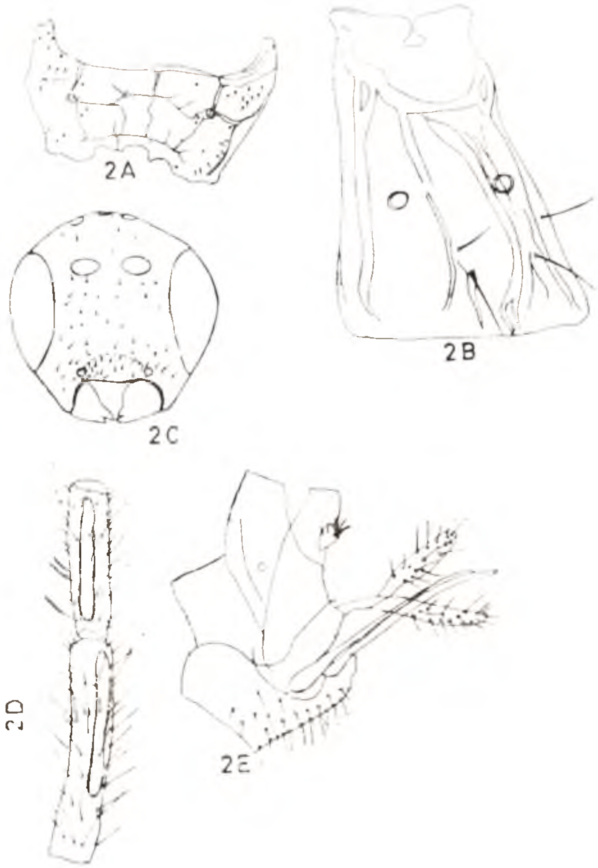

Fig. 2 A—E: *Neoephedrus kalimpongensis* n.gen. et.n.sp.
A. Propodaeum; B. Tergite 1; C. Head; D. Genitalia;
E. F_1 & F_2 of Antenna.

Wing (Fig. 1A) : Pterostigma 4 5 times as long as wide. 1/5 shorter than metacarpus, radial abscisa 1 too shoort, 1/8 or even lesser than radial abscisa II.

Abdomen lanceolate; tergite 1 (Fig 1C) slender 1/10 shorter than twice the width at spiracles, slightly broad posteriorly and 1 3 wider than apex; laterally carinated, paired tuberculate structure below the apex.

Leaf-like hairy ovipositor (Fig. 1F) sheath with almost straight, hairless apically toothed and pointed ovipositor.

Colouration: Head brown, mouth parts yellowish; antennae brown, thorax brown; wings pale yellow with yellowish brown venation; legs brown; tergite 1 brown dark at apex; ovipositor sheath brown.

Male—Unknown.

Measurements of the female in mm: Length of body 2.62 mm; Head 10L .30; FL 303; HW .431; TFL .23; ITL .12; TOL .045; GW .056; SD .041; SOL .03; VED .20; LED .10; Antenna—24-26 segmented; F_1L .22; F_1B .06; F_2L .16; F_2B

.06; Wing—PL .54; PW .12; MC .67. Tergite 1: L .225; B .12;

Material examined: **Holotype** ♀: 1 **paratype** ♀, reared from *Brachycaudus helichrysi* Kaltenbach on indet plant (Poaceae), Kalimpong (c 1400 m), West Bengal, 19.iii.1982, coll. A. K. Samanta & D. K. Tamili.

Neoephedrus kalimpongensis n. gen. et. n. sp. (Fig. 2: A—E)

Description of the female: Head (Fig. 2C) squarish, narrowed beyond eyes with dense long hairs; gena 2/5 shorter than longitudinal eye diameter; interocular line 1/3 longer than transfacial line and equal to facial line; tentoriocular line $\frac{1}{2}$ intertentorial line; clypeus with about 18 hairs; eyes slender; antennae 20 segmented, filiform, densely hairs; F_1 2/5 longer than F_2 (Fig. 2D) and 6 times as its width. Notaulices absent, laterally with long but sparse hairs; propodaeum (Fig. 2A) with roughly pentagonal central areola with almost developed longitudinal carinae, 3/5 as wide as long and laterally with few short and long hairs.

Wing: Pterostigma 7.5 times as long as wide and 2/5 shorter than metacarpus, radial abscisa I too short, 1/9 of radial abscisa II. Abdomen lanceolate, tergite I (Fig. 2B) 1/5 longer than twice the width at spiracles, broad posteriorly, 3/5 wider than apex, with longitudinal carinae and tuberculate structure below the apex.

Leaflike hairy ovipositor (Fig. 2E) sheath with almost straight, hairless, apically toothed and pointed ovipositor.

Colouration: Head brown, mouth parts yellowish; antennae yellowish brown; wings pale yellow with brownish venation; legs brownish; tergite 1 brown; ovipositor sheath brownish.

Male: Unknown.

Measurement of the female : Length of body 2.42 mm.

Head—IOL .30; FL .307; HW .412; TFL .22; ITL .112; TOL .052; GW .075; SD .056; SOL .045; VED .262; LED .12; Antenna—20 segmented, F_1L .225; F_1B .045; F_2L .19; F_2B .045; Wing: PL .675; PW .09; MC .932; Tergite I—L .307; B .138.

Material examined—**Holotype** ♀, reared from *Myzus persicae* on *Foeniculum vulgare* (Umbeliferae), Kalimpong (c 1400 m), West Bengal, 18.iii.82, coll. A. K. Samanta & D. K. Tamili.

Acknowledgement: Thanks are extended UGC for partly financing the work and the Head of the Department of Zoology for providing laboratory facilities. Mr. S. N. Basu also deserves thanks for camera lucida drawing.

REFERENCES

AGARWALA, BASANT, K. D. RAYCHOUDHURI & D. N. RAYCHAUDHURI (1981) A conspectus of aphidiid (Hymenoptera: Aphidiidae) parasites of aphids (Homoptera : Aphididae) in India. *Akitu*, N. S. 39, 1981.

SAHA, J. L., S. C. PODDAR, S. K. DAS, B. K. AGARWALA & D. RAYCHAUDHURI (1983) Studies of the Aphid parasites (Hymenoptera : Aphidididae) from Himachal Pradesh, India. *Akitu* (in press).

STARY, P. & D. RAYCHAUDHURI (1983) Aphid parasitoids (Hymenoptera : Aphididae) from N. E. India. *Oriential Ins.* (in press).

TAKADA, H. & N. D. RISHI (1980) Records of fifteen species of Aphidiidae (Hymenoptera) from Kashmir, India with description of three new species. *Kontyu*, 48(2), 234—240.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 97 *to* 100

BRIEF COMMUNICATION

PARASITISM, A KEY FACTOR IN CHECKING RICE PEST POPULATIONS

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(Received 25 July 1982)

The damage due to yellow stem borer *Scirpophaga incertulas* Walker and the gall midge *Orseolia oryzae* Wood Mason on rice crop in Warangal region is largely governed by the activity of an array of parasites/parasitoids and disease-producing organisms which occur at different stage of the pests. The activites of these natural enemies against stem borer was found to be the tune of 56—85% at 40—50 DAT (days after transplantation) of the crop while in respect of gall midge the egg larval parasitism was found to reach its peak (100%) when the crop attains 100 days age bringing down the pest population to below 1% damage level. These studies conducted at Agricultural Research Station, Warangal for two crop seasons 1980-81 underscrore the need for a critical stduy of the activity of different natural enemies and their impact on pest populatians so as to formulate a rational chemical intervention programme which will enable the activity of the natural enemies go unabated in the field.

(Keywords: biotic factors, abiotic factors, agro-ecosystem, parasite, parasitoid, parasitism, pathogens, nuclear polyhedrosis)

Yellow stem borer, *Scirpophaga incertulas* Wlk., and rice gall midge, *Orseolia oryzae* W. M., are the two major insect pests of rice in the Warangal region of Andhra Pradesh. Several biotic and abiotic factors influence the spread and development of these two pests (VENUGOPAL *et al.*, 1981). Of late, impelled by the bitter lessons learnt by excessive dependence on chemical control, the pest management practices have been reoriented to preserve the agroecosystem so that little harm is done to the natural enemies of the pests. Many parasitoids which thrive on different stages of insect pests were identified in rice fields of Telangana districts (RAMAIAH, 1968). Studies were conducted to identify the impact of these natural enemies on the major pests of rice in Warangal region. Field experiments were laid out specially to record pest incidence and the degree of parasitism during 1980—81 crop seasons.

The experiment was conducted with susceptible varieties namely Jaya and Tella Hamsa in Kharif and Rabi seasons respectively in a plot size of 500 sq m. The plot was divided into two equal halves and marked as plots A and B. Observations were recorded from 20 DAT at 10 days interval. Plot A was used for noting pest incidence. For convenience, five quadrats each measuring 1 sq m were marked based on stratified area sampling and the plots in the marked area were observed for total tillers, silver shoots and dead hearts. From plot B, 25 affected plants were collected and dissected in the laboratory to observe the stage of the insect found inside the plant like maggot/larvae and pupa and the extent of parasitism.

Yellow stem borer:—

Damage due to stem borer is reflected as dead hearts in the early stages and white ear heads in the late crop stages. Earlier reports revealed that its (distribution) incidence is influenced by crop and weather factors. Of the latter temperature plays a major role, but in this zone where minimum temperature rarely goes below 14°C during Nov—Dec., pest populations continue on Rabi crop without any break. Its spread and intensity in the rainy season appears to be in tune with the predominant rice variety of the region. Simultaneously its magnitude is largelv influenced by the activity of egg parasitoids like *Tetrastichus* spp. *Telenomus* spp., *Trichogramma* spp., etc.. and larval/pupal parasites like *Apanteles* spp., *Xanthopimpla* spp. In addition, disease causing organisms like *Beauveria* spp., *Bacillus* spp., and nuclear polyhedrosis viruses were common on larvae and pupae of this pest, particularly when populations were high as is evident from the present study (Table 1).

The impact of this borer on the crop varied from season to season. Damage started as early as September 30 DAT (30 days after transplanting) in 1980, whereas it was high on later stages of the crop (October—November) in 1981. This automatically influenced the consequent rabi crop and was reflected in 25—30% dead hearts before the crop attained 50 days age. In spite of high damage at heading stage in Kharif 1980, its effect was relatively low on the following rabi crop due to high egg parasitism (77%) in that season. Of the three types of egg parasitoids recorded, *Tetrastichus* sp., predominated in this zone, as was reported by earlier workers (KAMESWARA RAO, 1969). The larval/pupal parasitism and microbial activity varied according to the level of the pest population. It was as high as 56-58% at 40-50 DAT stage, when pest population produced 6 to 14% dead hearts. The reduced activity of these biological control agents during 1981 (23%) might have contributed to the increased incidence of the pest even on early stage rabi rice crop of 1981—1983.

Rice gall midge:—

Although rainfall, humidity and temperature influence the populations of midge, natural control due to entomophagous insects and pathogens plays a key role in regulating the pest populations (PRAKASA RAO, 1975). Of the several parasites/parasitoids recognised on different stages of gall midge, the parasitoids viz., *Platygaster* spp., *Neanastatus* spp., *Eurytoma* spp., *Aprostocetus* spp., *Proleptacis* spp , etc., are important. *Platygaster oryzae* and other species pass their entire life cycle on egg and larva of the midge and later emerge out during prepupal stage of the pest. Small emergence holes on the top of the gall (silver shoots) are indications of parasitization.

The data collected during 1980, 1981 crop seasons indicated that the impact of pest on the crop was maximum at 50-60 DAT stage for the August-transplanted crop. The infestation results in silver shoot formation three weeks after the initiation of attack by the pest and emergence of flies from tillers. The egg-larval parasitism was found to reach its peak (100%) when the crop attained 100 days age, bringing down the pest population to below 1.0% damage level (Table 1).

In spite of favourable temperatures large and successive crop areas in the following season and the availability of wide range of alternate hosts on field bunds, the pest declined to 2.0% level.

TABLE 1. Pest incidence and parasitization levels during 1980—81 and 1982—83 crop seasons.

Season and days after transplanting	Field incidence %				Parasitisation %					
	Gall midge		Stem borer		Gall midge Egg-larval		Stem borer Egg masses		Stem borer Larvae Pupae	
	1980-81	1981-82	1980-81	1981-82	1980-81	1981-82	1980-81	1981-82	1980-81	1981-82
Kharif (August transplanted)										
20	0.7	1.0	3.0	1.0	15.0	0.0	36.0	0.0	10.0	0.0
30	1.3	1.0	12.3	1.0	31.9	5.8	66.6	0.0	36.3	4.0
40	5.6	1.2	14.1	1.2	73.0	12.5	86.7	16.6	56.0	0.0
50	10.9	1.0	6.2	2.0	89.6	11.5	81.8	17.8	46.8	0.0
60	8.9	2.5	5.5	5.3	51.6	22.5	83.9	34.2	58.3	0.0
70	8.9	1.5	7.6	9.5	90.0	15.3	77.7	51.8	12.0	3.0
80	2.5	1.0	6.1	11 7	88.0	22.2	72.7	57.8	40.0	13.0
90	2.6	1.5	6.7	15.2	100.0	18.0	75.0	65.2	8.0	14 7
100	0.4	1.0	12.5	20.5	87.8	44.0	75.0	69.2	15.6	21.4
110	0.1	1.0	14.9	16.4	87.5	66.6	77.1	69.2	4 8	23.1
Rabi (January transplanted)										
20	0.0	1.0	2.7	4.2	0.0	0.0	18.0	28.0	5.0	5.4
30	0.3	1.8	4.1	9.9	—	12.0	26.2	49.0	11.2	11.5
40	0.8	2.1	5.6	30.7	—	10.0	42.1	70.3	23.6	12·5
50	0.5	0.9	6.8	24.2	—	5.0	50.0	68.8	15.0	23.0
60	—	1.1	8.2	6.6	—	—	44.5	47.0	19.8	22.0
70	—	0.5	5.7	4.2	—	—	39.8	39.5	15.2	26.1
80	—	—	6.3	2.7	—	—	29.4	16.4	21.7	18.0
90	—	—	6.8	3.8	—	—	52.5	11.0	20.2	12.3
100	—	—	4.9	11.9	—	—	43.1	—	14.0	19.8
110	—	—	4.1	12.5	—	—	—	—	12.0	19.8

This can only be attributed to the high rate of parasitism by *Platigaster* spp., and other parasitoids during October-November However, severe damage early in Kharif season crop underscores the need for artificial manipulation of this cycle by mass culturing and releasing suitable parasitoids in the field during August-September.

These studies clearly demonstrate the key role played by natural parasitoids/ parasites and pathogenic organisms of several stages of the highly destructive pests of the rice crop. Hence it is necessary to keep this in view while formulating pest control programmes through chemicals, so that natural control in the fields is not interfered with.

REFERENCES

KAMESWARA RAO, P. (1969) Relative efficacy of egg parasitism in the control of the rice stem borer, *Tryporyza incertulas* (Walker) in Andhra Pradesh. *The Andhra agric. J.*, **16** (6), 185—188.

PRAKASA RAO, P. S. (1975) Ecological studies on rice gall midge. IRC News letter, FAO, XXIV, 71—73.

RAMAIAH, E. (1967) Preliminary observations on the natural parasitisation in the egg masses of rice stem borer, *T. incertulas* W. *Andhra agric. J.* **14** (4), 21—25.

VENUGOPAL RAO,, N., B. H. KRISHNA MURTHY RAO, V. L. V. PRASADA RAO & P. SATYANARAYANA REDDY (1981) A note on the population fluctuations of rice gall midge and yellow stem borer in Warangal region of A. P., India. *Madras agric. J.*, **68** (4), 266—259.

Entomon, 1983, *Vol.* **8**, *No.* 1, *pp.* 101 *to* 102

BRIEF COMMUNICATION

FIELD EVALUATION OF VARIOUS DOSES OF PHORATE AND ALDICARB FOR THE CONTROL OF TWO-SPOTTED SPIDER MITE, *TETRANYCHUS URTICAE* KOCH ON THOMPSON SEEDLESS GRAPEVINES

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(Received 12 June 1982)

Various doses of phorate and aldicarb were evaluated to determine their effectiveness against the two—spotted spider mite, *Tetranychus urticae* Koch. on Thompson seedless grapevines. Soil application of aldicarb 2 and 3g a i / vine placed in furrows (10 cm deep and wide) on two sides of the vine at 15 cm distance from the base gave good control of the pest and prevented population build up for a period of one month after application.

(*Keywords:* Field evaluation, phorate, aldicarb, control, *Tetranychus urticae,* seedless grapevine)

Two-spotted spider mite, *Tetranychus urticae* Koch is a polyphagous pest of worldwide distribution. Heavy incidence of the pest on Thompson seedless grapes and commercial roses was observed in 1980 in Sangli district of Maharashtra and it caused heavy losses. There are no reports on efficacy of granular systemic pesticides against this pest on grapevine. Hence it was felt necessary to study the effectiveness of phorate & aldicarb in various doses against the mites under field conditions.

TABLE 1. Efficacy of various doses of granular pesticides against two—spotted spider mite.

Sl. No.	Treatment	Dose ai/vine (g)	mite population / 10 leaves				
			Initial	After treatment at			
				3 days	7 days	15 days	30 days
1.	Phorate 10 G.	1	413	429.0	596.6	512.0	379.6
2.	Phorate 10 G.	2	490	415.0	502.3	425.0	335.0
3.	Phorate 10 G.	3	448	263.3	303.0	290.6	314.0
4.	Aldicarb 10 G.	1	476	317.3	37.0	17.0	114.0
5.	Aldicarb 10 G.	2	438	140.0	4.6	7.0	6.0
6.	Aldicarb 10 G.	3	409	55.0	1.3	0.0	0.0
7.	Untreated	—	463	465.6	594.0	515.0	377.6
	S E±			7.22	3.05	3.41	3.99
	C D at 5%			22.18	9.37	10.51	12.32

An experiment was conducted in cultivator's field at Tasgaon, Dist. Sangli (Maharashtra) during 1981-82 in a randomized block design with three replications. An individual plot, consisting of 32 vines, spaced at 1.85 × 1.23 m, was treated with a weighed quantity of granules which were applied in furrows (10 cm deep and broad) on two sides of vines at a distance of 15 cm from the base. The granules were covered with soil and moderate irrigation was given. Nymphal and adult mite populations on 10 leaves selected at random on 5 vines from each plot were counted using a magnifying glass, prior to and at 3, 7, 15 and 30 days after treatment. The data were statistically analysed.

The data and results of statistical analysis (Table 1) revealed that aldicarb @ 2 and 3 g a i/vine were on par and significantly superior to rest of the treatments for the control of two-spotted spider mites and it prevented population build up up to 30 days after treatment.

The authors would like to acknowledge the help given by Shri. G. S. Mhetre, the pioneer cultivator of grapes from Tasgaon (Maharashtra). Similarly thanks are due to Dr. D. S. Ajri, Head, Department of Entomology, M. P. A. U., Rahuri for providing guidance.

Entomon, 1983, *Vo.* **8**, *No.* 1, *pp.* 103 *to* 104

BRIEF COMMUNICATION

OCCURRENCE OF *CHAROPS HERSEI* G. & M AS A PARASITE ON TARO HORN WORM *HIPPOTION OLDENLANDIAE* F.[1]

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(Received 31 December 1982)

Charops hersei an ichneumonid is recorded for the first time as an endoparasite on taro worm horn *Hippotion oldenlandiae*. The total life cycle of the parasite ranged from 22-27 days. The field parasitisation observed 6-10 per cent.

(Keywords: taro horn worm parasite, *Charops hersei, Colocasia, Hippotion oldenlandiae*)

During the field survey of pests and their natural enemies of edible aroids, horn worm *Hippotion oldenlandiae* F. a pest of *Colocasia esculenta* (taro), was observed to be attacked by an endoparasite in the farm, C T C R I. Trivandrum. It was dentified as *Charops hersei* Gupta and Maheswary (Ichneumonidae: Hymenoptera). The field level parasitization was found to be 6-10 percent while under laboratory conditions it was 33 percent. The parasite activity was noticed during September-October 1981. The ichneumonid parasitized first or second instars. Only one larva developed in a single host caterpillar. The parasitic larva lived inside the horn worm feeding its inner contents. The larva came out through the anal opening of the host, leaving the outer skin of the host which was just like that of moulted skin of horn worm (Fig. 1). The mature larva measured 12-15 mm in length. The period from the date of parasitization to the larval emergence from the host ranged from 13 to 17 days. The larva formed fine silk threads with oral secretions and covered the body with it and pupated inside. The one end of the puparium was attached to under-surface of the leaf. Puparium was oval shaped, attractive, ashy coloured with two black intermitent bands on either sides (Fig. 1). It measured 10 and 4 mm in length and width. The adult emerged through a small circular exit hole on the free end, after 9—10 days. The total life cycle took 22—27 days. Adults lived for 19—22 days in captivity. Adults are small (11—13 mm length and

Fig. 1. Showing the cast skin of the host worm by the endoparasite, puparium and adult of the parasite.

[1] Publication No. 346 Central Tuber Crops Research Institute, Trivandrum.

2 mm in width). Abdomen is honey brown, with light black tinge on dorso-lateral at the posterior end. Fore legs are creamy white, mesolegs upper half black and hind legs complete black. Sexes could be identified by the presence of small and short ovipositor of 2 mm, just protruding posteriorly.

This was the first report of *C. hersei* as a parasite on taro hornworm in India. Earlier *C. bicolor* was reported on rice skipper *Parnara methias* F (Chhabra and Singh, 1978) and *C. obtusus* Morl. on *spodoptera litura* F. from various crops in India (Patel *et al.* 1971).

Acknowledgements: The authors are thankful to the Director, C T C R I., Trivandrum for the facilities during the studies. The authors are grateful to the taxonomist Dr. I. D. Gauld and the Director, C I E., London for identifying the insect.

REFERENCES

CHHABRA., K. S. & JASWANT SINGH (1978) A new braconid parasite rice skipper *Parnara methias* F. (Lepidoptera : Hesperiidae) *Ent.* 3 (6), 1115—116.

PATEL, R. C., J. C. PATEL & J. K. PATEL (1971) New records of parasites of *Spodoptera exigua* Hb. and *S. litura* F. from Gujarat. *Ind. J. Ent.* 33 (1), 92—93.

Entomon, 1983, *Vol.* 8, *No.* 1, *pp.* 105 *to* 106

BRIEF COMMUNICATION

NOMENCLATURAL STATUS OF GENUS *AULACOPHORA* DUPONCHEL & CHEVROLAT AND *AULACOPHORA FOVEICOLLIS* (LUCAS)

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(Received 12 June 1982)

Duponchel & Chevrolat (1842) erected the genus *Aulacophora* based on the type-species *Galleruca quadraria* Olivier from Jawa. Maulik (1936) established the validity of the genus *Aulacophora* and showed its superiority over *Rhaphidopalpa* Rosenhauer. He mentioned that the genus *Aulacophora* could not be waived on the condition that it is preoccupied in the plant kingdom (International Code of Zoological Nomenclature vide Article No. 2).

The red pumpkin beetle, *Aulacophora foveicollis* (Lucas)-a serious pest of cucurbits in India, has been referred by different workers under the genus *Rhaphidopalpa* (Nayar *et al.*, 1976; Atwal, 1976). To clarify the present nomenclatural status of the genus as well as of the species, we have based our synonomies, given below on Maulik (1936). The name, *Aulacophora foveicollis* (Lucas), has also been confirmed by Mr. R. D. Pope of the British Museum (Natural History), London.

Genus *Aulacophora* Duponchel & Chevrolat

Aulacophora Duponchel & Chevrolat, 1842, IN d'Orbigny, Dict. Univ. Hist. Nat., 2:337 (Type-species: *Galleruca quadraria* Olivier; Europe).

Raphidopalpa Chevrolat, 1845, IN d'Orbigny, Dict. Univ. Hist. Nat., 6:5 (Type-species: *Crioceris abdominalis* Fab.; Europe).

Rhaphidopalpa Rosenhauer, 1856, Thiere Andalusia: 325 (Type-species: *Galleruca foveicollis* Lucas; Europe).

Acutipalpa Rosenhauer, 1856, l. c., : 327 (never used as a generic name fide Maulik, 1936).

Ceratia Chapuis, 1876, Comptes-Rendus Soc. Ent. Belg., 11: 19 (Type-species: *Aulacophora (Ceratia) marginalis* Chevrolat)

Triaplatys Fairmaire, 1879, Journ Mus. Godeffroy, 5, 14: 113.

Orthaulaca Weise, 1892, Deutsche Ent. Zeitschr., : 396 (Type-species : *Galleruca similis* Olivier; SE Asia).

DISTRIBUTION

Mediterranean coasts, India, Ceylon, Burma, Malay, Sumatra, Jawa, Borneo, Philippine Islands, Japan, Pacific Islands and Australia.

Aulacophora foveicollis (Lucas)

Galleruca foveicollis Lucas, 1849, Alger. Ent., : 542.

Galleruca nigriventris Redtenbacher, 1850, Denkschr. Akad. Wiss. Wien, 1: 50.

Galleruca abdominalis Gerstacker, 1862, Peters' Reise nach Mossambique, Zool., : 342.

Rhaphidopalpa foveicollis Joannis, 1866, Abeille, 3: 100.

Rhaphidopalpa abdominalis (Gerstacker) Fairmaire, 1868, Gen. Col. d'Eur., 4: 239.

Rhaphidopalpa foveicollis: Redtenbacher 1874, Fauna Austr., 3, 2: 490.

Aulacophora foveicollis (Lucas) Baly, 1879, Cist Ent., 2: 445.

Baly, 1886, Jour Linn. Soc. Lond., 20: 3, 5 & 16.

Maulik, 1936, Fauna India, Galeruc., : 173.

DISTRIBUTION

Greece, South Europe, Algeria, Egypt, Cyprus, Aden, Persia, India, Ceylon, Nepal and Burma.

Acknowledgements: The authors are thankful to Prof. B. S. Chahal, Head, Department of Entomology, Punjab Agricultural University, Ludhiana, for providing the necessary laboratory facilities and to Dr. M. S. Dhooria of the same department, for bringing the the subject under study into the limelight. J. S. M. is indebted to C. S. I. R., New Delhi, for the financial assistance as Pool Officer.

REFERENCES

Atwal, A. S. (1976) *Agricultural Pesta of India and South-East Asia.* Kalyani Publishers, Ludhiana 502.

Maulik, S. (1936) *Fauna of British India,* Chrysomelidae, Galerucinae. 173.

Nayar, K. K., T. N. Ananthakrishnan & B. V. David (1976) *General and Applied Entomology,* Tata McGraw-Hill Publishing Company Ltd., New Delhi 589.

Entomon, 1983, Vol. 8, No. 1, pp. 107

BOOK REVIEW

AGRICULTURAL ENTOMOLOGY, VOL. I. Ed. by P. D. SRIVASTAVA, M. G. JOTWANI, R. A. AGARWAL, S. R. WADHI, R. K. BHANOTAR and R. K. BHATNAGAR, 1982, 208 pp. Published by All India Scientific Writers' Society, A-2/78, Paschim Vihar, New Delhi 110 063. Price : India, Rs. 30.00. Foreign : $ 8.00/£ 4.00; By Air Mail add $ 2.00/£ 1.00.

This is a book of eleven chapters of as many articles on random topics in agricultural entomology, written by various authors. The topics dealt with are: Insect resistance in crops with special reference to sorghum, sugarcane and cotton: Ecological approach to pest problems; Insect nutrition and its significance in the management of pests and beneficial insects; Insects as biological control agents ; Predatory mites of India; Non-insect predators of crop pests; Microbial control of crop pests; Use of radio-active isotopes and radiations in entomological investigations; Plant quarantine in India; Recent developments in the chemical control of crop pests and Toxic residues of pesticides. The articles are reviews of the topics with special coverage of Indian works. Lack of figures is felt in some articles. The general get up of the book needs improvement.

The articles are useful to teachers, students and research workers in the relevent fields of agricultural entomology especially in India.

M. R. G. K. Nair

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(Form IV, Rule 8 of the Registration of Newspapers (Central) Rules, 1956)

1.	Place of publication :	Trivandrum
2.	Periodicity of publication :	Quarterly
3.	Printer's name, nationality and address :	V. K. Kesava Prabhu, Indian, Department of Zoology, University of Kerala, Kariavattom, Trivandrum 695 581.
4.	Publisher's name, nationality and address:	—Do—
5.	Editor's name, nationality and address :	—Do—
6	Name and address of individual who owns the newspaper :	Association for Advancement of Entomology, Department of Zoology, University of Kerala, Kariavattom, Trivandrum 695 581.

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Dr. V. K. Kesava Prabhu

Publisher, *Entomon*.

Trivandrum,
March 31, 1983.

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ACKNOWLEDGEMENT OF GRANTS

The Association for Advancement of Entomology has great pleasure to acknowledge with thanks the receipt of grants of Rs. 10,000/- from the Department of Science & Technology, Government of India, New Delhi and Rs. 3000/- from the Indian Council of Agricultural Research, New Delhi for publication of the journal *Entomon* during the year 1982—1983.

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Books: NAYAR, K. K. (1973) *Elements in Insect Endocrinology*, Prentice Hall, India, 56 pp. *Chapter in book compiled and edited*: GILBERT, L. I & D. S. KING (1973) Physiology of growth and development: Endocrine aspects, 249—370, *in*: *The Physiology of Insecta*, Vol. 1, 2nd ed. (ed. ROCKSTEIN, M.). Academic Press, New York & London.

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Printed by V. K. K. Prabhu at GEO Printers, Plamood, Trivandrum 695 004
for the Association for Advancement of Entomology.